ANNALS

OF

The Entomological Society of America

VOLUME XVI, 1923

EDITORIAL BOARD

HERBERT OSBORN, Managing Editor,
COLUMBUS, OHIO.

CLARENCE H. KENNEDY, Ass't Managing Editor,
COLUMBUS, OHIO.

FRANK E. LUTZ,
NEW YORK CITY, N. Y.

WM. S. MARSHALL,
MADISON, WIS

VERNON L. KELLOGG,
WASHINGTON, D. C.

WM. M. WHEELER,
BOSTON, MASS.

E. M. WALKER,
TORONTO, CANADA.

FREDERICK C. MUIR,
HONOLULU, HAWAII.

R. W. HARNED,
AGRICULTURAL COLLEGE, MISS.

R. A. COOLEY,
BOZEMAN, MONT.

G. C. CRAMPTON,
AMHERST, MASS.

PUBLISHED QUARTERLY BY THE SOCIETY
COLUMBUS, OHIO

Biology Dept. Library

CONTENTS OF VOLUME XVI.

WHEELER, ESTHER W.—Some Braconids Parasitic on Aphids and Their Life-History 1

VANDUZEE, M. C.—The Pelastoneurus of North America, (Dolichopodidæ, Diptera) 30

MATHESON, ROBERT—The Wax Secreting Glands of Pseudococcus Citri Risso 50

ALEXANDER, CHARLES P.—Undescribed Species of Japanese Crane-Flies, (Tipulidæ, Diptera) 57

MACGILLIVRAY, ALEX. D.—The Value of Landmarks in Insect Morphology 77

Proceedings of the Boston Meeting, 1923 85

FUNKHOUSER, W. D.—Walker's Species of Membracidæ from United States and Canada 97

THOMPSON, W. R.—A Criticism of the "Sequence" Theory of Parasitic Control. 115

SMITH, ROGER C.—The Life Histories and Stages of Some Hemerobiids and Allied Species (Neuroptera) 129

GARMAN, PHILIP—Notes on the Life History of Clastoptera Obtusa and Lepyronia Quadrangularis 153

FRACKER, S. B.—A Review of the North American Coreini (Heteroptera) 165

Members of the Entomological Society of America v

REGAN, W. S.—An Introductory Study of the Psammocharinæ with Special Reference to the American Species of the Genus Lophopompilus Radoszkowski 177

CLAUSEN, CURTIS P.—The Biology of Schizaspidia Tenuicornis Ashm., a Eucharid Parasite of Camponotus 195

MANK, HELEN G.—The Biology of the Staphylinidæ 220

SMITH, M. R.—The Life History and Habits of Bicyrtes Quadrifasciata Say ... 238

MCATEE, W. L., and MALLOCH, J. R.—Notes on American Bactrodinæ and Saicinæ 247

TIETZ, HARRISON M.—The Anatomy of the Digestive System of the Carolina Locust 256

WASHBURN, F. L.—Notes on Collecting Insects in the Marquesas Islands 274

SMITH, RALPH H.—Technique in Studying by Dissection the Internal Anatomy of Small Insects 277

WADLEY, F. M.—Factors Affecting the Proportion of Alate and Apterous Forms of Aphids 279

ALDRICH, J. M.—The Genus Philornis—A Bird-infesting Group of Anthomyidæ .. 304

OSBORN, HERBERT, and LATHROP, F. H.—The Genus Phlepsius in North America (Homoptera) 310

DELONG, D. M.—The Distribution of the Leafhoppers of Presque Isle, Pa., and their Relation to Plant Formations 363

MILLER, ELLEN ROBERTSON—Observations on the Bellura (Lepidoptera) 374

EWING, H. E.—Holosiro acaroides, New Genus and Species—the Only New World Representative of the Mite-like Phalangids of the Suborder Cyphophthalmi 387

Officers of the Entomological Society of America.

PRESIDENTS.

J. H. Comstock	1906–7	V. L. Kellogg	1915
William Wheeler	1908	F. M. Webster	1916
Henry Skinner	1909	Lawrence Bruner	1917
J. B. Smith	1910	Nathan Banks	1918
Herbert Osborn	1911	J. G. Needham	1919
S. A. Forbes	1912	L. O. Howard	1920
C. J. S. Bethune	1913	J. M. Aldrich	1921
P. P. Calvert	1914	Arthur Gibson	1922
T. D. A. Cockerell	1923		

FIRST VICE-PRESIDENTS.

James Fletcher	1907	J. S. Hine	1915
J. B. Smith	1908	E. P. Felt	1916
Herbert Osborn	1909	E. M. Walker	1917
S. A. Forbes	1910	T. D. A. Cockerell	1918
Lawrence Bruner	1911	James W. Folsom	1919
A. D. Hopkins	1912	F. E. Lutz	1920
P. P. Calvert	1913	Arthur Gibson	1921
James G. Needham	1914	W. A. Riley	1922
Wm. S. Marshall	1923		

SECOND VICE-PRESIDENTS.

Henry Skinner	1907	J. M. Aldrich	1915
C. J. S. Bethune	1908	A. L. Melander	1916
A. D. Hopkins	1909	H. C. Fall	1917
V. L. Kellogg	1910	E. P. VanDuzee	1918
A. D. MacGillivray	1911	R. V. Chamberlin	1919
A. D. Hopkins	1912	Edith M. Patch	1920
P. P. Calvert	1913	E. C. Van Dyke	1921
James G. Needham	1914	R. A. Cooley	1922
F. E. Lutz	1923		

SECRETARY-TREASURER.

J. Chester Bradley	1906–09
C. R. Crosby	1910
A. D. MacGillivray	1911–15
J. M. Aldrich	1916–20
C. L. Metcalf	1921

MANAGING EDITOR.

Herbert Osborn	1908–

ANNALS

OF

The Entomological Society of America

Volume XVI MARCH, 1923 Number 1

SOME BRACONIDS PARASITIC ON APHIDS AND THEIR LIFE-HISTORY. (HYM.)*

ESTHER W. WHEELER.

The present paper deals with the larval development of some very interesting Hymenopterous parasites of the Aphididæ. Most of the known parasites of these destructive insects belong to the Braconid subfamily Aphidiinæ, the numerous genera of which appear to parasitize aphids almost exclusively. In spite of their abundance, practically nothing has been known previously regarding the structure of the larvæ, although the group has received considerable attention at the hands of economic entomologists on account of its practical importance in the natural control of injurious plant-lice.

The adult Aphidiinæ are small, slender creatures, usually about two mm. long, with delicate, transparent wings. In color, they vary from black through reddish-brown to yellow. The mandibles are triangular, bidentate; the antennæ, filiform, many-segmented; the lateral mesothoracic plate or mesepisternum, very large; the legs are long and slender with very small claws; the abdomen of the female is lanceolate and very flexible; that of the male, short ovate. The wing veins are considerably reduced and exhibit great variation, but there are always two complete basal or median cells.

On account of the greatly scattered literature, a résumé is given of the previous studies on the larval stages and

* Contributions from the Entomological Laboratory of the Bussey Institution, Harvard University. No. 218.

development of other parasitic Hymenoptera as well as the Aphidiinæ, including the Chalcidoidea, Proctotrypoidea, Ichneumonoidea, etc.

I wish to express my gratitude to Professor C. T. Brues and Professor W. M. Wheeler for their criticism and encouragement in this work, and also to Doctor Edith M. Patch and Mr. A. B. Gahan for assistance in the identification of the species of the Aphididæ and Aphidiinæ.

LARVAL TYPES.

The types of larva used in the ensuing discussion may be briefly defined as follows:

1. *Hymenopteriform.* This type is fourteen-segmented, apodous, tapering toward the extremities, and having very small head and tail segments. It is common to all species discussed in their mature stage except possibly (a) *Polynema* (here Ganin's ('69) descriptions may be those of younger stages); (b) *Perilampus*, *Orasema*, and *Spalangia*, which have tuberculate hymenopteriform larvæ; and (c) *Archirileya inopinata* Silv. ('20), whose fifth stage with an anal vesicle probably belongs to the next type.

2. *Caudate.* The caudate type possesses an anal segment elongated to form a simple tail usually without appendages or with a globular anal vesicle. The first segment is enlarged into a definite head. The intervening segments are either of the same diameter or decrease slightly toward the tail.

3. *Cyclopoid.* The cyclopoid larva is divided into (a) a large cephalothorax, composed of the head and at least one of the thoracic segments, and (b) a narrow, segmented, tail-like region ending in a dentate or hairy bifurcation. As the name suggests, it is much like the Crustacean in appearance. The enormous head bears long, curved mandibles. This type is found chiefly in the Proctotrypoidea.

4. *Planidium.* The heavily chitinized, motile, ectoparasitic larva, called a planidium, is widest at its thorax; the head is rather rounded with strong mandibles, but the posterior part of the body is attenuated, often ending in two bristle-like appendages. Spines may be present dorsally and ventrally. This type is restricted to the Chalcidoidea.

Some other larval types found among the parasitic Hymenoptera, less widespread but nevertheless striking, are the following:

5. *Embryonic larva.* This larva is composed of a sac-like group of undifferentiated cells and has been found only in a species of *Polynema* of the Chalcidoidea, by Ganin ('69).

6. "*Spindle-shaped.*" This type exhibits a definite head with a prominent ventral prolongation, a tapering body with circular fringes of hairs, and a long tail with basal serrations. The only species found to have this larva is *Polynema bifasciatipenne* Girault ('10).

7. *Eucoilaform.* This kind of Cynipid larva has a bird shaped head without mandibles, a definite thorax with three pairs of unsegmented appendages, and narrow abdominal segments curving dorsally, ending in a tail at right angles to the dorsum. It has been found as the first instar of *Eucoila keilini* Kieff. (Keilin '13).

8. *Agriotypiform.* The mature larva of *Agriotypus armatus* Walk. has been called an agriotypiform larva. The diameters of the segments vary, presenting a very irregular body outline. The mandibles are coarsely serrated. (Klapálek '89).

9. *Chrysidiform.* This type, found in *Chrysis dichroa* Dhlb. (Ferton '05), is characterized by a peculiar caudal segment, the two tips of which are mobile, retractile, and lie bent toward one another when at rest.

CHALCIDOIDEA.

Ganin ('69) gives an account of the larva of an undetermined species of *Polynema*, parasitic on the eggs of a dragon fly, *Agrion virgo*. The embryo leaves the egg when only a "mere flask-shaped sac of cells." After five or six days, this embryonic larva takes on a definite larval form. The head and tail segments are of about the same width as the body segments. The head is square with two thick lateral antennæ and two smaller, anterior, median, very sharply pointed projections. The anal segment bears three pairs of tubercles.

Ayers ('84) in his thesis "On the Development of *Œcanthus niveus* and its Parasite *Teleas*," devotes a small part of his paper to the two earliest larval stages of the parasite which has since been identified as the Chalcidoid *Polynema bifasciati-*

penne Girault ('10). The animal hatches into the yellow yolk-mass of the *Œcanthus* egg. At first, it is composed of head and tail with from five to eight rather indistinct body segments between, each bearing a row of spines about its equator. The head is elongated in front to form a blunt process and, strange to say, has four mandibles (probably the two mandibles, the labrum, and the labium), the posterior anterior ones working at right angles to the lateral ones. The long tail shows on the ventral part of its base some tooth-like projections with a varying number of basal spines. The second stage resembles Ganin's first stage or cyclopoid larva of *Teleas* and Marchal's intermediate larva (Proctotrypoidea), to be described later. The body is rather flat and possesses a prominent head and hooked mandibles. The tail is not posterior but projects ventrally and ends in a "dentate knob." The mouth has a strikingly hooked lower lip which may be bifid, but always remains concave on its upper surface. The antennæ are very noticeable.* Ayers thought there were three or four larval stages but unfortunately did not complete his study.

The Chalcidoid *Ageniaspis* (=*Encyrtus*) *fuscicollis* Dalm. was found by Bugnion ('92), parasitic on the caterpillar of *Hyponomeuta cognatella*. This insect develops polyembryonically, and the multiple embryos form a chain, provided with a membranous covering, such as Marchal ('04) found. About them there is developed an extensive ramification of the tracheæ of the host. The first larval stage found is hymenopteriform, tapering more posteriorly than anteriorly, and bent only slightly. The chitin is free posteriorly, forming "une sorte de capuchon caudal." This may represent one of the two following conditions, (1) either the caste skin adheres to the anal segment as Silvestri ('19, a and b; '20) has found recently to be of common occurrence among Chalcidoids; or (2), the process of molting has begun, commencing at the tail and proceding forward, as de la Baume-Pluvinel ('15) found to be the case with the Braconid *Adelura gahani*. His figure resembles more closely the second condition, but the first is of greater distribution.

* McColloch ('15) found a larval stage of *Eumicrasoma benefica* Gahan, parasitic on the chinch bug, to be similar to this larva.

Embleton's ('04) *Comys infelix* is related to the *Ageniaspis* of Bugnion's paper, but has different habits. It is parasitic on a Coccid, *Lecanium hemisphæricum* var. *filicum*. There is a great disproportion of sexes, about one thousand females to one male. After ovipositing in the thoracic region of the host, the female applies its mouth to the wound. This habit of feeding from the puncture, made by the ovipositor, is characteristic of many Chalcids. The first larva of *Comys* has its thickest portion in the middle and possesses two tail-like appendages. The second larval stage is marked by an increase in diameter and the disappearance of the tails. The third stage, of the usual hymenopteriform shape, has a queer modification of the tracheal system. From each of the four spiracles "there is a double tracheal tube running out into the host's body; these two branches become subdivided and ramify in the host's tissue." Whether these ramifications originate from the host or parasite was not determined.

Riley ('07) has reviewed Silvestri's work ('06) on *Litomastix*, which oviposits in the egg of a species of *Plusia*. Two types of larvæ develop from the one egg—about one thousand normal and about one hundred "asexual larvæ." The "asexual larvæ" with their very strong mandibles are probably useful in breaking down the tissues of the host for the consumption of their relatives, but they soon degenerate, never attaining the adult state. He calls this phenomenon "precocious development of caste."

Wheeler ('07) discovered a new type of Chalcidoid larva in the genus *Orasema*, parasitic on Formicidæ. The young larva or planidium partly encircles the neck of the ant semi-pupa. In 1912, Smith found a planidium of *Perilampus hyalinus* Say, and in 1917, another planidium of a parasite on *Chrysopa*, called *Perilampus chrysopæ* Crawford. Thompson ('15) discovered planidium larvæ as secondary parasites of a Noctuid. Recently Ford ('22) records a planidium larva of *Perilampus* sp., parasitic on a Locustid, *Conocephalus fasciatus* De Geer. *Spalangia muscidarum* Richardson ('13), described by that author as ectoparasitic on house-fly pupæ, has a first stage larva which he considers as belonging to the planidium type.

Packard ('16) published a study of three Chalcidoids parasitic on *Mayetiola destructor* Say, the Hessian fly. They are external parasites, with five larval stages and a naked pupal

stage. The first, *Eupelmus allynii* French, has a curious egg usually with a stalk at each end "fastened to the inner surface of the puparium by a little net-like structure." The mandibles are the same in all stages except for a successive increase in size. The mature larva has characteristic hairs on the body, a labrum with six points, and a bristle near the base of each mandible. The second, *Merisus destructor* Say, has an elongate, kidney-shaped egg, very similar to that of *Homoporus* (= *Micromelus*) *subapterus* Riley, the third Chalcidoid studied. Both have two pairs of tubercles on the larval head. The mandibles of the later stages are alike in being rather straight and pointed for a Chalcidoid, but that *H. subapterus* is more suddenly sharpened.

Aphycus lounsburyi How. (Smith and Compere '20), an Encyrtid, is parasitic on the black scale, *Saissetia oleæ* Bern. I quote their description of the oviposition which was observed on a scale glued to the lower side of a glass slide. The parasite backs up to the scale and inserts the ovipositor under the rim, "when the egg is forced from the uterus into the ovipositor; it is compressed to a long cylindrical form so as to pass through the channel in the long, slender ovipositor. The egg is hardly recognizable as it passes through the ovipositor, for so rapid and even is the movement that it looks more like a flow of quick-silver than the passage of an egg. The forepart of the egg, which still retains its cylindrical form, acts like a probe to penetrate some distance beyond the tip of the ovipositor into the body of the scale. Suddenly the liquid contents of the egg rush forward, inflating the anterior portion, * * * *. The hind section of the egg remains tube-shaped after the contents have rushed forward. The parasite then withdraws the ovipositor, leaving the tube molded in position, supporting the bulb or main body at one end, and the other end of the tube projecting through the integument of the host into the outer air." After hatching, the larva is suspended at its posterior end by the stem which protrudes through the scale shell and probably "functions as an air line" for the respiration of the insect. It remains attached to this stem until the third stage, when the tracheæ become well developed.*

* Since this paper was written, studies on Chalcid hyperparasites of aphids have been published by Haviland (Quart. Jour. Micr. Sc., N. S., '20, LXV, no. 257; '22, LXVI, 321-338.)

PROCTOTRYPOIDEA.

The life-histories of the Proctotrypoids have been studied chiefly by Ganin ('69), Kulagin ('92, '97), and Marchal ('06). Marchal's work on "Les Platygasters" brings to date the work of the others and presents the entire embryological development in detail.

Platygastrinæ, such as *Synopeas rhanis* Walk., have a long stalked egg and a very characteristic cyclopoid larva. It has a large head and a narrow tail, ending in two appendages. The head bears extremely long, curved, sharp mandibles, two-jointed antennæ, a strongly chitinized labrum with teeth, and a ligula (labium?) with a smaller series of teeth. The insect hibernates in the "intermediate stage." The head and tail characters of the first stage persist, but the body is large and rounded. The "secondary" larva has no visible segmentation. The mandibles, minute, bidentate, are situated in the mouth, which has muscles to open and close it and is probably adapted to sucking. The third stage, not separated by a molt as Ganin thought, has small, sharp mandibles and is clearly segmented.

Trichacis remulus Walk. is interesting as an example of those Proctotrypoidea which lay their eggs in the nerve chain of their host, where they induce the formation of gall-like structures.

Pemberton and Willard ('18 b) describe a Proctotrypoid, *Galesus* (=*Diapria*) *silvestri* Kieff., which may live either as a primary or as a secondary parasite of the fruit-fly pupa. This species has a large head, curved mandibles, very prominent antennæ, and a bidentate labrum. It passes through three or four similar larval stages, the others having small heads and simple bodies.

ICHNEUMONIDÆ.

Lyonnet ('32) described and figured the mature larva of *Ophion luteus* L.

Ratzeburg ('44) decided that the Ichneumonidæ had four and five larval stages. *Anomalon* (=*Exochilum*) *circumflexum* L. has a first instar of the caudate type, but with a very accentuated tail. In the second and third stages, the larva becomes stouter, and this tail gradually disappears until it is completely absent in the fourth stage, small-headed hymenopteriform larva.

Paniscus (=*Parabates*) *virgatus* Fourc., parasitic on *Mamestra pisa*, according to Newport ('52), deposits a black egg with a stalk, the end of which is imbedded in the caterpillar's skin. The egg cracks longitudinally. The larva pokes its head out, bites a hole in the host's skin and begins to feed. As it increases in size, it gradually emerges but remains attached to the egg shell. The three exuviæ of the larva form a covering for the posterior part of the body. Newport found the larva of *Ichneumon atropos* Curtis between the heart and stomach of the pupa of *Sphinx ligustri*. It has lateral and ventral tubercles on all the body segments. Ventral tubercles have not been discovered elsewhere on Ichneumonid larvæ. The anal segment is produced into two spines.

Riley ('88) made a study of *Thalessa atrata* Fab. and *Thalessa lunator* Fab., which lay their eggs in burrows of *Tremex columba* L. He describes a hymenopteriform larva of *lunator* and figures a lateral view of the head (which, by the way, is upside down). Bugnion ('04) found the egg of *Rhyssa persuasoria* (a related genus) with an extremely long stem, the whole measuring 12 to 13.5 mm.

Limnerium (=*Campoplex*) *validum* Cress., a parasite of the brown-tail moth, *Euproctis chrysorrhœa* L., according to Timberlake ('12), has three larval stages. The first has an enormous head and a long tail; the mouth is characterized by a circular rim. In his figure there are ventral projections on some of the middle segments. The second stage has a cylindrical body of thirteen segments, with a funnel-shaped mouth cavity. The third stage is of the usual hymenopteriform type, but with thirteen segments and complicated facial characters.

BRACONIDÆ.

Early mention of a Braconid larva was made by Ratzeburg ('44), who described the larval stages of *Microgaster nemorum* Hart. (now *Apanteles fulvipes* Hal.). The first instar is a twelve-segmented, simple, caudate larva. The second stage possesses a double pair of silk glands and an anal vesicle. The other three stages show a gradual change to the fifth stage hymenopteriform larva.

Seurat ('99) in a work on the "Hyménoptères entomophages" discusses the growth of the externally living Braconid,

Doryctes gallicus Rein., parasitic on *Callidium sanguineum* L. Ten to fifteen *Doryctes* larvæ are found on a single host with their mouths applied to cuts made in the chitin. The mature larva has the usual thirteen segments and a head, which bears the mouth, labrum, strong mandibles, maxillæ with palpi, labium, and orifice of the silk glands. On its anterior dorsal surface is a pair of small antennæ. The body is covered with spines. He distinguishes six larval stages.

Keilin and Picardo ('13) published an account of *Diachasma crawfordi* Keil., a Braconid parasitic on the fruit-fly, *Anastrepha striata* Schm. A curious fact about its larva is that, since the dorsal surface is concave, it appears to be inverted. The nervous system and the two Malpighian tubules seem to be dorsal to the stomach; the salivary glands and gonads just under them, overlapping the ventral part of the stomach. Dorsally, the median heart is visible. This superficial semblance of inversion is heightened by appendages (really dorsal) on the first and third thoracic segments. The pair on the first thoracic segment are large and rounded with three papillæ on the apex of each; the pair on the third thoracic segment are very much smaller, but have sharply pointed tips. Laboulbène ('58) found the larva of an Ichneumonid, *Pimpla* (=*Polysphincta*) *fairmairei* Lab. which has "pseudopodia" on each segment of its convex dorsal surface. They are single protuberances with a ring of hairs on the tip. The *Diachasma* larva is composed of a head and twelve or thirteen segments. The mouth opening is located on the anterior dorsal surface. The region of the clypeus, distinctly separated from the so-called "pleural plates," is strongly chitinized and probably corresponds to the labium of the Aphidiinæ. The mandibles are large and curved as in other Opiinæ which have been studied. He found antennæ on the clypeus, and near them a pair of palpoid organs. Another pair is situated at a short distance ventrally, on the pleural plates. The mature larva is covered with spines. The mandibles are small, far apart, and weakly chitinized. The labrum has several pairs of sense organs in the form of hairs and single or double chitinous rings. Otherwise the face is much like that of a mature Aphidiine larva.

De la Baume-Pluvinel ('15) related the facts pertaining to the growth of another Braconid, *Adelura gahani* Baume,

parasitic on a Dipteron. The first instar has a large, distinct head and tail, with twelve segments between. The animal is concave dorsally and like *Diachasma crawfordi* appears to be inverted. It has well-developed organs including tracheæ. The antennæ and mandibles are dorsal as well as the paired tufts of hair on the margin of each dorsal segment. The second stage is marked by an unchitinized head, a slight prolongation of the anal segment, three prominent pairs of papillæ, small mandibles, and by the absence of tracheæ. The third stage is covered with teeth, but these are not described in sufficient detail for comparison with those found in the Aphidiinæ. The head of this instar is strongly chitinized, divided into plates, and covered with hairs and circular papillæ. Tracheæ are present.

Thersilochus conotracheli Riley develops in the plum curculio (Cushman '16). The first larval stage, very much like that of *Limnerium validum* Cress., has thirteen segments and is characterized by a tail and a large head with "heavily chitinized, acute, curved mandibles, and very delicate labrum, maxillæ, and labium." The second stage has lost the prominent head, tail, and strong mouth-parts. The third instar is separable by its stouter size and wider head (0.07 mm. wider). The fourth is curved, tapering toward the ends like most parasitic larvæ, i. e., hymenopteriform. The fifth is very similar, but larger and more heavily chitinized.

From the work done on the Mediterranean fruit-fly in Hawaii by Back and Pemberton ('18) and Pemberton and Willard ('18, a and b), the life-histories of several parasites are recounted. The Opiine, *Diachasma tryoni* Cam., has four larval stages. It hatches with a large, heavily chitinized head, long sickle-shaped mandibles, two palpi and two teeth on the labium. Ventrally, behind the head, are two bag-like appendages, which seem to arise from the suture between the head and the first thoracic segment. They may be the same as the prothoracic legs which Keilin found on *D. crawfordi*. The body of the second stage larva is composed of thirteen segments and a small, poorly differentiated head with soft mandibles. The third stage is much like the second. Except for the head, the fourth is covered with very attenuate, acuate spines. The mandibles are more pointed. There are present also the

maxillæ, two pairs of palpi, and a chitinized labrum with its palpi (probably the antennæ).

Willard has recently published ('20) the results of parasitism on the melon-fly, *Bactrocera cucurbitæ* Coq. by another Opiine, *Opius fletcheri* Silvestri. This has a large-headed, strong-mandibled larva, like the other Opiinæ, with two teeth on the labium and appendages on the second segment. The remaining three larval stages are hymenopteriform; the mandibles of the second and third stages are very slightly chitinized, for the larva lives then on the soft parts of the host. The head of the mature instar has characteristic hairs and papillæ. The body spines are like those of *D. tryoni* in shape, but slightly larger and thicker.

In 1918, Muesebeck grew a Braconid, *Meteorus versicolor* Wesmael, on larvæ of the brown-tail moth. The first stage, a caudate larva, has a long anal appendage and "a large, brown, heavily chitinized head capsule, containing a pair of strong, curved mandibles." The head of the second stage is not chitinized, and the anal appendage is smaller. In the third, the mandibles are chitinized, and the anal appendage is very short.

Another parasite of the brown-tail moth, a Braconid, *Apanteles lacteicolor* Viereck, is found in the posterior half of the host's body, where, in its first stage, it passes the winter. Dorsally, a transverse row of short, posteriorly projecting spines is present on each of the last nine segments. The mandibles are very heavy and pointed. The larva has a tail and the caudal swelling or "bladder-like structure" known as the anal vesicle. Ratzeburg ('44), Seurat ('99), and Kulagin ('92), have studied this organ; and Weissenberg ('08) summarized their work and determined it to be an evaginated portion of the intestine. The tracheal system in *Apanteles glomeratus* Latr., the species studied by Weissenberg, is not formed until the last endoparasitic stage, when the vesicle begins to be reinvaginated, hence it is possible that its function is respiratory, but he considers that, as an excretory organ, it is of more importance. In the second stage larva of *A. lacteicolor*, it is much enlarged, but the tail is small; the unchitinized mandibles are bidentate. The third instar has pectinate mandibles. Tracheæ are hithertofore not present. The vesicle disappears.

APHIDIINÆ.

According to De Geer (1771), the first observers to notice internal aphid parasites were Swammerdam (1737) and Leeuwenhoek (1695, 1700). De Geer observed that the essential internal organs of the host are not touched at first by the parasite, and that the dead aphid is attached to the substratum, not by the legs, but by a quickly hardening, sticky substance. He also depicts the mature larva, its face, and the curved pupa in tiny figures.

An interesting footnote by Haliday ('34, p. 98) in his "Classification of Parasitic Hymenoptera" describes the habits of *Aphidius rosæ* Hal.

I have been able to find only two papers dealing with studies made on the larval stages of the Aphidiinæ. Seurat ('99) made an incomplete life-history study of a species of *Aphidius*, dwelling chiefly on the anatomy and tracheal system of the larva. His figure illustrating the latter resembles a late stage secondary Chalcid parasite such as *Lygocerus*. I have not yet found any tracheæ in Aphidiines. His diagram of the anatomy will be discussed later. The second study is that of Timberlake ('10) which is mentioned in another section of this paper.

THE LIFE-HISTORY OF THE APHIDIINÆ.

The following species were used in this study:

TABLE 1.

Parasite	Aphid Hosts	Plant
Aphidius ribis Hal	*Macrosiphum* sp.	Jerusalem Artichoke
Aphidius phorodontis Ash.	*Myzus persicæ*	Radish
Lysiphlebus testaceipes Cress.	*Macrosiphum tanaceti*	Tansy
Praon simulans Prov.	*Myzus persicæ*	Radish
Ephedrus incompletus Prov.	*Aphis pseudobrassicæ*	Radish
	Myzus persicæ	Radish
Diæretus rapæ Curtis	*Myzus persicæ*	Cabbage

MATING.

Aphidiines which have never been at liberty will mate freely in petri dishes or even in small glass vials. Copulation lasts from 30 to 60 seconds. Withington ('08) found that it averaged 52 seconds for *Lysiphlebus* sp. (=*Ephedrus*).

OVIPOSITION.

Oviposition generally occurs during the morning from eight o'clock until one. After that time, the females stand scattered about, usually on the under side of the leaves or in inconspicuous crevices of the stems.

During the egg laying period, when in the vicinity of the aphid, the parasite begins to vibrate the antennæ excitedly and stealthily approaches from behind. The wings are outspread and the abdomen bent under the thorax so that the point projects in front of its head.* In this position, it makes a sudden lunge at the aphid, sometimes, though not always, tapping the animal first with its antennæ. In order to hold the ovipositor in place long enough to lay the egg, it is forced to beat its wings frantically or else it would lose its balance in this acrobatic position. The whole process lasts only a few seconds. The aim of the ovipositor is not sure, for although the abdomen is probably the most advantageous spot, the thorax or a leg is sometimes punctured. I have witnessed attempts to oviposit in bits of debris in the neighborhood of aphids and even in the aphid eggs at about the natural height of the aphid abdomen. Likewise, the instinct of the insect to lay eggs in unparasitized hosts, as sometimes is claimed, is not exact. Especially, if the supply of aphids is limited, the same female, in the course of her rounds, has been observed to return three and four times to oviposit in the same aphid. Although it may come back, the parasite leaves the aphid immediately after egg laying and never feeds at the puncture.

* Hunter ('09) Illustration, p. 144, fig. 4.

REPRODUCTIVE SYSTEM.

The egg is colorless, elliptical, narrower at one end than at the other, with its long axis slightly curved. It is rather transparent and has no stalk. In two species its dimensions are as follows: *Aphidius phorodontis* Ash., length, 0.125 mm.; greatest width, 0.031 mm.; *Ephedrus incompletus* Prov., length, 0.148 mm., width, 0.038 mm. (Fig. 1 a).

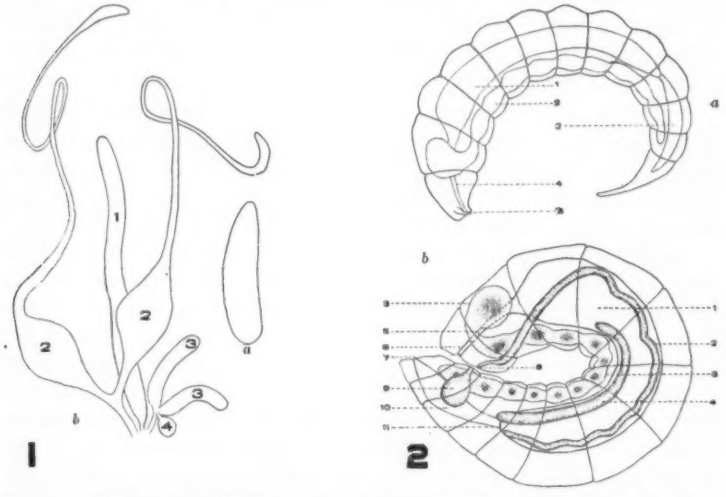


Fig. 1. *Ephedrus incompletus* Prov. *a*, Egg; *b*, Reproductive system; 1, Alkaline gland; 2, Ovaries; 3 Poison glands; 4, Receptacle.

Fig. 2. *Aphidius phorodontis* Ash. *a*, Second stage larva; 1, Stomach; 2, Nervous system; 3, Rudimentary intestine; 4, Œsophagus; 5, Mandible; *b*, Fourth stage larva; 1, Stomach; 2, Silk gland; 3, Nervous system; 4, Malpighian tubule; 5, Œsophagus; 6, Mouth; 7, Anus; 8, Silk gland orifice; 9, Gonad; 10, Intestine; 11, Blind extremity of the stomach.

The female organs of *Aphidius phorodontis* Ash. and *Ephedrus incompletus* Prov. were examined and found to be similar. As those of the second species were examined in freshly killed material, the following description is based on *Ephedrus* rather than *Aphidius* which was represented only by specimens in alcohol.

The eggs are packed very closely in the two ovaries. The extremities of the ovarioles are coiled in the fatty tissue about the stomach. The end is thickened, but soon narrows down

to a long tube which, in turn, enlarges into a bulb. The narrow tube is four to five times as long as the bulb. The short ducts of the two ovarioles join in the oviduct, which soon meets the ovipositor. Also leading to the ovipositor are the poison gland and the alkaline gland. The two poison glands are shorter than the bulb and squared at their ends. At the point where they come together in a duct, there is a round receptacle. The single alkaline gland is slightly thicker than the poison gland and three times as long. (Fig. 1, b). It is characterized by its contents, which consist of globular, rather evenly packed masses.

Pemberton ('18 b, p. 437) has depicted a Braconid reproductive system, that of *Diachasma tryoni*, which has three parts—ovaries, poison glands, and alkaline gland. However, each ovary consists of two tubules which taper more gradually to the tips; the poison glands are very long and sinuous, large at the base, where they enter the receptacle, and attenuated at the ends; the alkaline gland is more or less leaf-shaped rather than tubular.

Larval Stages of *Aphidius phorodontis* Fitch.

Four or five days after oviposition, small larvæ were found in *Myzus persicæ*, varying in length from 0.376 to 0.481 mm., of white color, with the mandibles brown at the tips. There are thirteen segments. Probably the narrow, attenuated tail, which is as long as the three preceding segments, is composed of two, making, in reality, fourteen. The head, about as long as the tail, tapers to a truncated extremity where the mouth is situated. The two mandibles which protrude anteriorly, are long, very sharply pointed and slightly curved inward. The animal seems to be smooth in this stage, but in the second stage (length 0.496–0.706 mm.) the tail has a few scattered spines, and there are occasional spines visible on the dorsum. (Fig. 2 a). The tail is somewhat shorter and the head smaller with inconspicuous antennal palpi. The mandibles are of the same shape and size as the first stage, although they seem smaller because of the increase in the size of the insect.

The third stage is characterized by the loss of the tail. Although the larva was previously curved ventrally, the curvature now becomes exaggerated so that it is unable to straighten out. Since the curve varies, the measurements

of length can be only approximate. The length of this stage in its curved position is from 0.466 mm. to 0.646 mm. The anal segment has a blunt point, but no definite elongation. The shape of the body has changed. Segments two to seven are of about the same diameter; the following ones taper only gradually. The width of the anal segment, at its base, is about one-half that of the second segment.

The fourth stage (approximate length 0.676–1.022 mm.) is similar, but larger, thicker, with a comparatively smaller head and posterior segment. (Fig. 2 b). I have been unable to find the mandibles of the third and fourth stages.

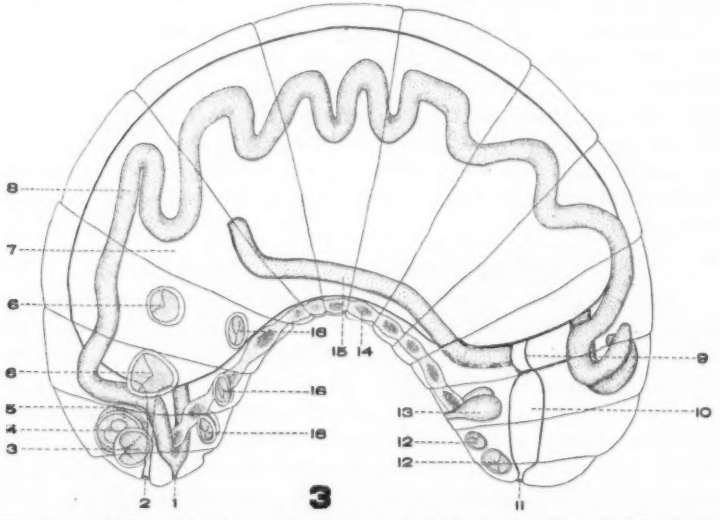


Fig. 3. *Aphidius ribis* Hal., mature larva; 1, Silk gland orifice; 2, Mouth; 3, Imaginal disc of the eye; 4, Imaginal disc of the antenna; 5, Supra-œsophageal ganglion; 6, Imaginal discs of the wings; 7, Stomach; 8, Silk gland; 9, Ileum; 10, Rectum; 11, Anus; 12, Imaginal discs of the genetalia; 13, Gonad; 14, Nervous system; 15 Malpighian tubule; 16, Imaginal discs of the legs.

The fifth stage or mature larva (approximate length 1.082–1.503 mm.) is white, with brown-tinted stomach cavity and white spots under the chitin, probably groups of adipose tissue. The animal, composed of fourteen definite segments, is of a different shape from the preceding. (*cf.* lateral view of *A. ribis*, fig. 3). It is widest at the middle and tapers toward

the head and anal segment. The last segment is blunter than the head. The dorsum is thickly set with reclinate, short spines which fade out toward the ventral portion. The ventrum is smooth except on the head, where the spines are like those of the back, but with a tendency to point forward. The head, similar to that of *Diæretus rapæ* Curtis, is about as long as the second segment or the thirteenth and fourteenth together.

The process of molting was not observed. Consequently, the determination of the five stages has been made by appearance and by differences in size.

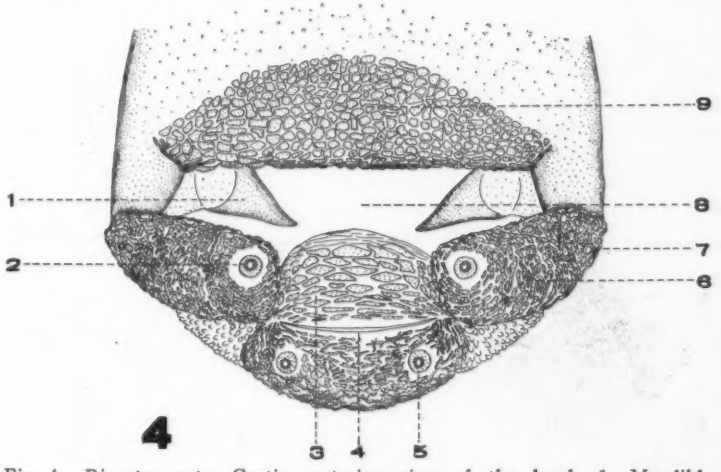


Fig. 4. *Diæretus rapæ* Curtis, anterior view of the head. 1, Mandible; 2, Maxillary palpus; 3, Labium; 4, Silk gland orifice; 5, Labial palpus; 6, Maxilla; 7, Papilla on the maxilla; 8, Mouth opening; 9, Labrum.

Mature Larva of *Diæretus rapæ* Curtis.

The shape is like that of other mature Aphidiine larvæ—hymenopteriform, wide at the middle and tapering toward the two ends with the posterior end rounder than the anterior. The body is covered with blunt spines which are reduced to simple folds ventrally, but dorsally on segments three to seven, the spines become very sharp, reclinate, and are arranged in rows.

The mouth opening, which is anterior in position, is long, rectangular in shape (Fig. 4). At its short lateral ends, extend-

ing only a quarter of the distance across the cavity, are the small mandibles, with heavily chitinized tips. The labrum is differentiated from the remaining smooth dorsal part of the head segment by its covering of very blunt spines, or rather, protruding, truncate, chitinous plates, bearing occasional tiny, needle-pointed hairs. Below the mouth, in the center, is the labium, on each side of which and under the mandible is a maxilla. The labium is circular in shape, and divided in halves by the slit-like orifice of the silk glands. The upper half

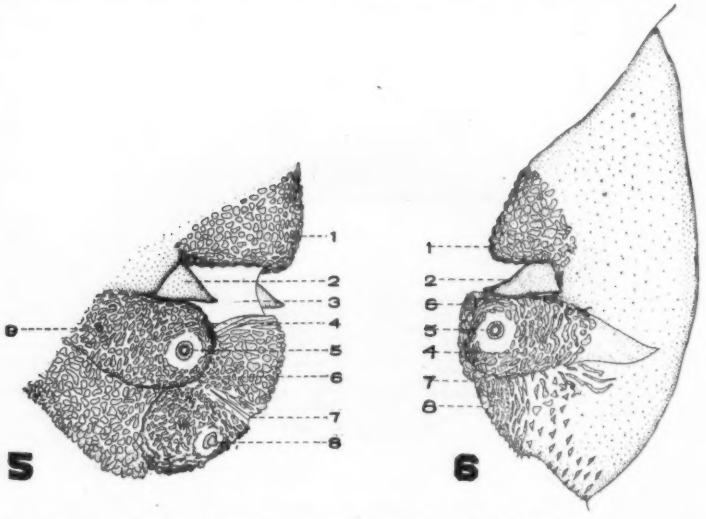


Fig. 5. *Diæretus rapæ* Curtis, anterior lateral view of the head.
Fig. 6. *Aphidius ribis* Hal., lateral view of the head. 1, Labrum; 2, Mandible; 3, Mouth opening; 4, Maxilla; 5, Maxillary palpus; 6, Labium; 7, Silk gland orifice; 8, Labial palpus; 9, Papilla on the maxilla.

is covered with large chitinous plates which degenerate into folds at the mouth and at the gland opening; the lower half, more oval and bearing two palpi, has more rounded plates, which become spine-like ridges ventrally. The maxilla is egg-shaped with the broad end toward the mouth, and is clothed by irregular narrow plates which form concentric circles about the maxillary palpus. This palpus, of the same size as the labial palpus, is situated near the mouth opening. It is composed of a short peg-like projection set in a heavily chitinized circle.

On the central lateral portion of the maxilla is a small palpus-like papilla about one-fourth the size of this large one. Beneath the labium, the surface is very thickly set with heavy spines, although not sharp like the dorsal spines of the animal.

The head of *Aphidius ribis* Hal. is very similar, (Fig. 6). The mandibles are of the same shape, but a little longer. The plates of the maxilla do not extend so far back, and the small papilla seems to be absent.

First Stage Larva of *Ephedrus incompletus* Prov.

Length 0.524 mm., white with ferrugineous mandibles. Head large, broadly rounded, almost as long as the three following segments which are the widest; the rest of the body tapering to the anal segment, which is about as long as the head and composed of a slightly curved tail with successive rows of hairs, and two shorter, hairless, ventral projections. Around the equator of each body segment is a fringe of hairs, which seem to be connected at their bases so as to form a saw-edged band, whose teeth become blunter ventrally except on the last two segments before the tail, where they are sharp all the way round. The body is curved, but can be straightened out, a fact which is not true for the later stages. In the anterior ventral part of the head is the broad, oval mouth opening, across which the two small, short mandibles operate. Anterior to the mouth are two prominent palpiform appendages, the antennæ. Ventrally, near the suture of the second segment, are two pairs of protuberances, probably sensory papillæ.

Timberlake ('10) has described the first stage larva of *Praon simulans* Prov. which reminds one of *E. incompletus*. The head, according to his figure, is rounded, but comes to a point on its ventral anterior portion, in front of the small mandibles. The first three segments are apparently without hairs, but he describes the "metathoracic and first to ninth abdominal segments provided with a comb of comparatively coarse bristles along their posterior margins." The tail has a few bristles at its apex and the two smaller ventral appendages.

He also figures and describes briefly the first stage larva of *Aphidius rosæ* Hal. (?) which is like *A. phorodontis* except for the "projecting lobes" on each side of the ventral posterior margin of the head, and a slight irregularity in the diameters of segments two to seven.

DIGESTIVE SYSTEM.

The first and second stage larvæ of *Aphidius phorodontis* have a long, narrow stomach, widest in the fourth and tapering to a point in the tenth segment. (Fig. 2 a). Thence into the tail there extends a narrow mass of cells, tapering at both ends, and representing the rudiments of the posterior intestine. The silk glands are not yet formed.

In the third stage, the stomach is of a similar shape, but wider throughout, as is also the body of the animal. The posterior intestine is formed and the ileum and rectum are becoming differentiated in outline.

In the fourth stage there is an increase in size of all the organs except the nervous system. (Fig. 2 b).

The mouth opening of the mature larva (Fig. 3 of *Aphidius ribis* Hal.) lies as far above the most anterior point of the head as the salivary gland orifice is below. The narrow œsophagus runs back to the middle of the third segment where it suddenly enlarges into the vast stomach, which almost fills the body cavity as far as the eleventh segment. The lining of the œsophagus is composed of a thin inner membrane and a single layer of large gland cells, surrounded by a layer of sustentative tissue. Outside of the whole, muscle fibres are visible. (Fig. 8 c). The proclinate gland cells are parallelograms in section, becoming irregular near the thicker portion where the œsophagus abruptly opens into the stomach. There is no definite proventriculus as Seurat ('99) suggests in his figure, but some of the cells at the juncture of the œsophagus and stomach project into the pouch and suggest a peritrophogen. However, no peritrophic membrane has been observed. The wall of the stomach has one or more layers of gland cells separated from the cavity by a thin membrane. These cells are rectangular, more or less rounded on the inner edge, which is the longer side of the cells situated in the forward part of the stomach, and the shorter side of those in the posterior portion. (Figs. 8, a and b).

Although the intestine is closely applied to the wall of the stomach, there is no open connection between them. The ileum and rectum are distinct. The latter has a thick outer membrane of sustentative tissue, resembling that of the œsophagus. It is filled with glandular cells provided with long

stems. A single cell starts at the membrane and extends till it almost meets those coming from the opposite wall. Each cell has a prominent nucleus in its stem and a granular secretion in its globular part. (Fig. 8 d). Such fully developed gland cells are remarkable in a non-functioning part of the alimentary tract, for there is no open connection between the stomach and intestine nor between the Malpighian tubules and intestine. This is contrary to the findings of Seurat ('99) who figures the tubules as opening into the intestine.

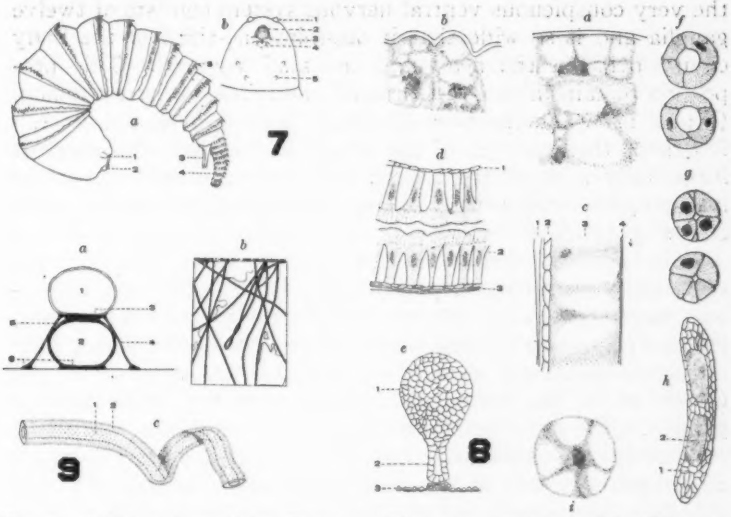


Fig. 7. *Ephedrus incompletus* Prov. *a*, First stage larva; 1, Mandible; 2, Antenna; 3, Appendage; 4, Tail; 5, Fringe of hairs. *b*, Ventral view of the head of the first stage larva. 1, Antenna; 2, Mouth opening; 3, Mandible; 4, Labium; 5, Papilla.

Fig. 8. *Aphidius phorodontis* Ash. *a*, Longitudinal section of the gland cells of the stomach near the center; *b*, The same, near the posterior extremity; *c*, Longitudinal section of the left half of the œsophagus (arrow indicates the direction of the food passage); 1, Muscle fiber; 2, Sustentative tissue; 3, Gland cells; 4, Inner wall. *d*, Longitudinal section of the closed intestine near the center; 1, Sustentative tissue; 2, Gland cells; 3, Muscle fiber. *e*, Longitudinal section of a single gonad; 1, Gonad proper; 2, Duct; 3, Ventral wall of the twelfth segment. *f*, Cross sections of the silk gland. *g*, Cross sections of the Malpighian tubule. *h*, Cross section of a paired ganglion; 1, Outer layer; 2, Inner layer. *i*, Adipose cell.

Fig. 9. *Praon simulans* Prov. *a*, Diagrammatic cross section of a cocoon; 1, Empty body of the aphid; 2, Cocoon proper; 3, Filled in slit through the ventral part of the aphid's abdomen; 4, Outer wall; 5, Inner wall; 6, Points of attachment to the substratum. *b*, Surface view of a portion of the outer wall. *c*, Silk; 1, Inner core; 2, Outer covering.

From the region where the stomach is applied to the intestine, the two Malpighian tubules arise and extend forward on each side to the fifth or sixth segment, where they end in an upward curve. In cross-section they are composed of three to six cells, surrounding a very small lumen, and have large nuclei. (Fig. 8 g).

NERVOUS SYSTEM.

In the second stage larva (*Aphidius phorodontis*, Fig. 2 a) the very conspicuous ventral nervous system consists of twelve ganglia and is so wide that it occupies one-third of the body cavity between the head and the anal segment. This proportion remains about the same till the fourth stage is reached, (Fig. 2 b), when the nervous tissue is reduced to about one-fourth of the contents of the body; and in the fifth stage it forms only a small part, (Fig. 3). In the fourth stage, the last ganglion (thirteenth) is larger and longer than the more central ganglia.

The nervous system of the mature larva (Fig. 3) was especially observed in *Aphidius ribis* Hal. The large supra-œsophageal ganglion, located dorsally in the second segment, is about four times as large as each of the four following ganglia—the subœsophageal, situated in the second segment at the crotch of the two joining silk glands, and the three thoracic ganglia. The remaining eight ganglia, completing the series of thirteen, are of the same size, except the last, which is again larger and situated in the twelfth segment between the two gonads. The ganglia are all thick and lie close together. The commissures are also thickened, causing the ventral nerve chain to appear of almost the same width throughout. It is, of course, not circular in cross-section (see Fig. 8, h), but each ganglion is composed of two closely applied lateral halves which together form a sausage-shaped mass.

The gonads are two in number, bulb-like in shape, with a common duct (Fig. 8, e). Each is a solid mass of cells. The duct is partly hollow, but not yet open.

Lateral to the supraœsophageal ganglion is a large imaginal disc, that of the antenna, and lateral to this, but extending forward into the first segment, is the disc of the compound eye. The large disc of the mesothoracic wing and the smaller one of the metathoracic wing are centrally situated on each side of the

third and fourth segments. The three pairs of leg discs, lie ventrally in segments two, three and four, and the two pairs of discs representing the genitalic appendages in segments thirteen and fourteen. Just before pupation, these discs already exhibit the parts of the adult organs, so that, for example, the segments of the antenna are clearly visible.

No heart nor tracheal system has been observed in the larvæ.

SILK GLANDS.

The silk glands first become clearly visible in the fourth stage, as a slightly wavy, single tube in the dorsal region on each side of the stomach. Anteriorly these enter a common duct of smaller diameter in the region of the suture between the first two segments. (Fig. 2 b). In this stage, they are much narrower than the Malpighian tubules which originate at the juncture of the stomach and intestine and extend forward, parallel to the ventral line of the stomach, ending in the fourth segment.

In the adult larva the large, sinuous glands are the most conspicuous organs in specimens stained with borax carmine. (Fig. 3). They are composed of a single layer of cells, usually four in cross section, with prominent nuclei. The diameter of the lumen is almost as great as the thickness of the secretory epithelium. (Fig. 8 f). The two glands lead to a short duct in the head, close to the orifice. Posteriorly they terminate in an incomplete coil in the eleventh and twelfth segments.

LOCOMOTION OF THE LARVÆ.

The first stage larva is very active. I have examined carefully the youngest larva of *A. phorodontis*, which can move either backward or forward. To advance, the head is retracted and the tail drawn back dorsally. Then the head is suddenly shot forward, the tail elongates and gives a push downward. When the animal moves backward, the tail is not raised dorsally, but is pushed out in a line with the body. It is then drawn in with a hook-like movement, while the head is simultaneously retracted. The natural curve of the body causes the animal to move always in a circle. Yet, this is the only type of movement necessary for an animal enclosed in a rounded cavity like that of the aphid's body.

Pemberton and Willard ('18 b) say of *Diachasma tryoni:* "The first instar moves about by contorting the body, and its movements are aided by gripping fresh tissues coming into contact with the mandibles coincident with the body movements." It is possible that these Aphidiinæ may use their mandibles in such a way, but I have never observed them in the act.

In its later stages the larva is more or less torpid, moving slowly with worm-like waves of muscle contraction along the successive segments.

POSITION OF THE PARASITE IN THE BODY OF THE HOST.

In the majority of cases, the young larvæ (Stages I to III) are found in the posterior half of the abdomen. In twelve perfect specimens of *A. phorodontis*, nine were in the normal position. In one of the three abnormal cases the parasite was in the anterior part of the abdomen; in the second, in the middle; and in the third the larva was too large for the size of the host and occupied most of the abdominal cavity.

The later stages, IV and V, are curved so that the head and tail usually meet. If they are slightly straightened, the head is nearer the anterior extremity of the host. This position is very constant, as I have found only a single exception. The parasite is always confined to the abdomen.

FORMATION OF THE PUPAL ENVELOPE.

When the contents of the host's body has been exhausted, the gorged larva fills the cavity almost to the bursting point and then proceeds to cut an opening, along the midventral line of the abdomen. This slit soon becomes so widely spread by the strain on the delicate cuticle of the host that a broad oval opening is formed.* It must be a considerable strain on the fat and tightly housed insect to accomplish the movements necessary, but when once the hole is made, it starts diligently to work. First the edges of the now oval slit are attached to the substratum. Next the bottom is filled in, and the whole cavity is lined with strands of silk. Muesebeck ('18) observed that the Braconid, *Apanteles lacteicolor*, looped

* Webster ('08) considers that the parasite stretches out the aphid by certain movements which I am sure are only those made by the larva in spinning the cocoon after the slit has been cut.

the thread, but in this case, it is put on rather irregularly, sometimes with two or three superimposed so that the thread appears to be compounded.

The silken thread itself is very fine and tenuous, more oval than round in cross-section, brownish white and slightly opaque. It is composed of an inner core, with an outer covering. (Fig. 9 c). Branching of the thread sometimes occurs, but this is an exception rather than the rule.

Matheson ('07), in speaking of the silk glands of *Apanteles glomeratus* L., says that the anterior portion serves as a reservoir and the posterior as a secretory organ. The secretion is enveloped in a different material, "a peripheral layer of silk oxydized in the reservoir." The inner core and outer covering of this Aphidiine silk suggests the silk he describes, but as mentioned before, the parts of the silk glands are undifferentiated, as the same type of cells extend throughout the entire length of the organs.

If turned upside down while attaching the aphid, the larva will worm itself entirely out of its covering in its endeavor to reach some foundation. If the shell of the aphid is thus lost, the larva spins a cocoon, but I have never been able to bring one in this predicament to maturity. If the larva comes partly out and finds the substratum, it drags the aphid husk after it, just as a snail draws its shell, and soon sticks it down.

Praon similans Prov., after cutting the slit, leaves the aphid's body entirely, but uses it as a sort of roof. The now rounded slit is covered over, while tent-like walls of a light layer of silk, separated by a thin membrane (Fig. 9 b) serve to hold the aphid body over the larva, while it spins its cocoon underneath. (Fig. 9 a). This central capsule is made of the same silk as the outer walls, but is packed tightly and thickly together without any intervening membrane. How this membrane is formed I have been unable to determine; perhaps the silk strands are made more fluid by exuded juices from the mouth. One could hardly attribute to such simple glands the power of secreting thread and a membrane, probably fluid, at the same time.

The oval cut is entirely filled in and serves as the top of the main cocoon, which is of a rounded, oval shape and of about the same size as the dead aphid's body, exclusive of the appendages.

REARING THE PARASITES.

Three experiments in rearing *Aphidius phorodontis* under control were carried on in May and June with these results.

In the first experiment, four females parasitized, in four days, twenty-one aphids out of seventy six. The offspring took an average of twenty-three days until maturity.

In the second, three females parasitized, in four days, thirty-six aphids out of seventy, and the adults emerged in twenty days.

In the third, four females parasitized, in six days, twenty-eight out of twenty-nine aphids. The developmental period was approximately twenty days.

The hosts in the last experiment, as would be expected, were very heavily parasitized. Also, seventeen more aphids were present ultimately than at the start. The same is true in the first where six more were present. This increase is natural, as the viviparous female aphids are constantly laying their young.

In the three series of rearings, there were eleven cases out of the fifty-nine parasitized specimens where more than one larva was present in a single host; six cases with two, four cases with three, one with seven, and one with eight. In only two instances where two or three were present, were the parasites of the same age and these larvæ were in the first instar. In the others, one larva was much older, and the young ones were usually dead. In the case of the seven larvæ, all were in the first instar; but in that of the eight, three second stage larvæ and one first stage individual were alive, although the remainder were dead.

Since never more than one larva reaches maturity, a problem presents itself, concerning the reason for the disappearance of the supernumerary larvæ. Though usually dead in the presence of a later stage, they are not necessarily devoured when they die, nor are they killed; but they must be devoured sooner or later, since no vestige of them remains at the time of pupation. There are four possibilities for their death:

First, by starvation; but this can hardly occur, since the host always contains plenty of food material after the death of the larvæ. Starvation would be likely only if they were capable of digesting but one kind of food tissue, which might have already been consumed by the older larva.

A second possibility is through the action of some poisonous principle. Timberlake ('10) suggests that "the more advanced and stronger larvæ secrete or excrete some fluid or material into the body of the host, which eventually destroys their younger or weaker brothers and sisters."

Third, through deliberate injury by the older inhabitant. Pemberton ('18 a) pictures a larva *D. tryoni* with its mandibles buried in the body of an *Opius humilis* larva and observes that they feed on the extra parasites. In only one case did I find an old larvæ feeding on the half empty husk of a smaller one, but I was unable to determine if they were both the same species.

Fourth, by accidental injury. A slight mechanical injury, unobservable because of their minute size, might cause death, and afterwards, whether dead or alive, the animal would be devoured because it had the misfortune to be in the path of the sweeping mandibles of the dominant parasite. When the larvæ are all of the same size and strength, the idea of starvation or poisoning seems impossible. Therefore the survivor must be the one to escape injury. Yet I have never noticed an instance where all larvæ of the same stage were dead.

LENGTH OF LIFE.

Withington ('08) found a species of *Lysiphlebus* (= *Ephedrus*) on *Aphis maidis* which required thirteen to twenty-three days for development from egg to adult under a daily mean temperature of 62.6° F.

Hunter ('09) observed that 17.66 days was the average developmental period of *Lysiphlebus tritici* during the whole year.

During April and May, *Aphidius phorodontis* required approximately nineteen to twenty-three days. Some meager data, obtained during May and June, indicated from thirteen to eighteen days. The acceleration at this time is probably due to higher temperature.

The larval stages last about ten days and the pupal condition, four or five days.

Without food, the life of the adult varies from two to seven days, four days being the mean; with food, life is prolonged to eight days and longer, but the limit has not been determined.

SUMMARY.

1. Various larval types of parasitic Hymenoptera are defined.

2. Previous papers on the larval stages of the Chalcidoidea, Proctotrypoidea, and Ichneumonoidea are reviewed.

3. The life-histories of Aphidiinæ (Braconidæ) are discussed with special reference to the larval stages of *Aphidius ribis* Hal., *Aphidius phorodontis* Ash., *Lysiphlebus testaceipes* Cress., *Praon simulans* Prov., *Ephedrus incompletus* Prov., and *Diæretus rapæ* Curtis.

BIBLIOGRAPHY.

Ashmead, W. H., '88. Pr. U. S. Nat. Mus., XI, no. 760. *Aphidius phorodontis* Ash., p. 662.
Ayers, H., '84. Mem. Boston Soc. Nat. Hist., III, no. 3, 225-281, 8 pl.
Back, E. A., and **Pemberton, C. E.,** '18. U. S. Dept. Agr., Bull. 536, 1-119, 24 fig., 21 pl.
Baume-Pluvinel, G. de la, '15. Arch. Zool. Exp., 47-59, 1 pl., 3 fig.
Bugnion, E., '92. Recueil Zool. Suisse, 435-534, 5 pl.
Bugnion, E., '04. Bull. Soc. Ent. France, 80-83, 2 fig.
Cresson, E. T., '79. Comstock, Rep. Ent., Rep. U. S. Dept. Agr., p. 208, *Lysiphlebus testaceipes* Cress.
Cushman, R. A., '16. Jour. Agr. Res., VI, no. 22, 847-856, 9 fig., 1 pl.
De Geer, C., 1771. Histoire des Insects. Stockholm, II, part 2, 866-875, 1 pl., 10. fig.
Embleton, A. L., '04. Trans. Linn. Soc. Zool., London, ser. 2, IX, 231-254, 2 pl.
Ferton, Ch., '05. Ann. Soc. Ent. France, ser. 3, LXXIV, 56-104, 2 pl.
Ford, N., '22. Can. Ent., LIV, 199-204, 1 fig.
Ganin, M., '69. Zeitschr. f. wiss. Zool., XIX, 381-451, 4 Taf.
Girault, A. A., '10. Jour. N. Y. Ent. Soc., XVIII, p. 254, *Polynema bifasciatipenne* Gir.
Haliday, A. H., '34. Ent. Mag., I, 480-491; II, 93-106. *Aphidius ribis* Hal., p. 101.
Hunter, S. J., '09. Bull. Univ. Kansas, IX, no. 2, 1-221, 65 fig., 3 pl.
Keilin, D., et **Baume-Pluvinel, G. de la,** '13. Bull Sc. France et Belgique, ser. 7, XLVII, fasc. 1, 87-104, 2 pl.
Keilin D., et **Picardo, C.,** '13. Bull. Sc. France et Belgique, ser. 7, XLVII, fasc. 2, 203-214, 4 fig.
Klapalek, F., '89. Ent. Monthly Mag., XXV, 339-343, 7 fig.
Kulagin, N., '92 (a). Zool. Anzeig., 85-87.
Kulagin, N., '92 (b). C. R. Cong. Int. Zool., Moscou, 253-277.
Kulagin, N., '97. Zeit. f. wiss. Zool., LXIII, 193-235, 2 Taf.
Laboulbene A., '58. Ann. Soc. Ent. France, 797-816, pl. 17, no. 2, fig. 1-11.
Leeuwenhoek, A. van, 1695. Letteres du 20 aout, p. 132.
1700. Lettres du octobre, p. 284-289.
Lyonnet, P., '32. Mémoirs postumes, Paris. *Ophion luteum,* p. 256, pl. 24, fig. 6-7.
McColloch, J. W., '15. Jour. Econ. Ent., VIII, 248-267, 3 fig.
Marchal, P., '04. Arch. Zool. Exp. et. Gen., II, 257-335, 5 pl.
Marchal, P., '06. Arch. Zool. Exp. et. Gen., IV, 485-640, 13 fig., 8 pl.
Marshal, T., '91. Les Braconides. André, Spec. Hym. Europe. Gray. p. 615. *Diæretus rapæ* Cur.

Matheson, R., and **Ruggles, A. G.,** '07. Am. Nat., XLI, 567-585, 3 pl.
Muesebeck, C. F. W., '18. Jour. Agr. Res., XIV, no. 5, 191-206, 4 pl.
Newport, G., '52. Linn. Trans. XXI, 61-102, Tab. 8-9.
Packard, C. M., '16. Jour. Agr. Res., VI, no. 10, 367-381, 2 pl.
Pemberton, C. E., and **Willard, H. F.,** '18 (a). Jour. Agr. Res., XII, no. 5, 285-295, 4 pl.
Pemberton, C. E., and **Willard, H. F.,** '18 (b). Jour. Agr. Res., XV, no. 8, 419-465, 41 fig., 1 pl.
Provancher, L., '89. Additions et Corrections au Vol. II de la Faune Entomologique du Canada. Hym. p. 153 and fig. 16, *Praon simulans* Prov., p. 156, *Ephedrus incompletus* Prov.
Ratzeburg, J. T. C., '44. Die Ichneumon der Förstinsekten. Berlin, III, 13-29, Taf. 9, fig. 1-32 for larvæ.
Richardson, C. H., '13. Jour. Morph., XXIV, no. 4, 513-549, 17 fig.
Riley, C. V., '88. Insect Life, Wash., I, 168-179, 4 fig., 1 pl.
Riley, W. A., '07. Ent. News, XVIII, 9-11.
Seurat, L. G., '99. Ann. Soc. Nat. Zool., ser. 8, X, 1-159, 5 pl.
Silvestri, F., '19 (a). Boll. Scuol. Agr., Portici, XIII, 70-126, 38 fig.
Silvestri, F., '19 (b). Boll. Scuol. Agr., Portici, XIII, 127-192, 34 fig.
Silvestri, F., '20. Boll. Scuol. Agr., Portici, XIV, 219-250, 20 fig.
Smith, H. S., '12. U. S. Dept. Agr., Bur. Ent., Tech. Ser. 19, Part 9, 33-69, 8 fig.
Smith, H. S., '17. Psyche, XXIV, no. 3, 65-68, 4 fig.
Smith, H. S., and Compere, H., '20. Monthly Bull. Cal. State Dept. Agr., IX, no. 8, 310-320, 4 fig.
Swammerdam, J. J., 1737–1738. Bybel der Natur. Leyden, I, p. 217.
Thompson, W. R., '15. Bull. Sc. France et Belgique, ser. 7, XLVIII, fasc. 3, 310-349, 5 fig.
Timberlake, P. H., '10. Psyche, XVII, no. 4, 125-130, 2 fig.
Timberlake, P. H., '12. U. S. Dept. Agr., Bur. Ent., Tech. Ser. no. 19, Part 5, 71-92, 9 fig.
Webster, F. M., '08. Pr. Ent. Soc. Wash., IX, 110-114, 1 pl.
Weissenburg, R., '08. Sitz. Gesell. nat. Freunde, Berlin, no. 1, 1-18, 9 fig.
Wheeler, W. M., '07. Bull. Amer. Mus. Nat. Hist., XXIII, 1-93, 6 pl.
Willard, H. F., '20. Jour. Agr. Res. XX, no. 6, 423-438, 13 fig.
Withington, C. T., '08. Trans. Kansas Acad. Sc., XXI, 138-140.

THE PELASTONEURUS OF NORTH AMERICA

(Dolichopodidae, Diptera.)

By M. C. Van Duzee,
Buffalo, N. Y.

In the following pages I have described eleven new forms of *Pelastoneurus*, several of which have remarkable distinguishing characters. The accompanying plate gives drawings of wings or wing tips where it seemed that they would be a help in determining specimens.

Dr. J. M. Aldrich has greatly assisted me in the preparation of this paper by sending me specimens of several of the species described by him, thus enabling me to more fully differentiate these species and make out the new tables of species. He also sent me his undetermined material, among which were several interesting forms new to me.

The drawings were made by Mr. William Wild, of East Aurora, N. Y.

Pelastoneurus dissimilipes and **cyaneus** Wheeler.

These two forms, although very much alike in color and in the form of the hypopygium and its lamellæ are easily separated by the bend in the last section of the fourth vein. In *cyaneus* (Fig. 10) it is further from the cross-vein and much more abrupt than in *dissimilipes* (which is about as in 21), in the former it is bent near its apical third, the upturned portion being only about half as long as the part from the cross-vein to the bend; in *dissimilipes* the bend is before the middle and so gradual as to make it difficult to say exactly where it starts. The hind tibiæ are black in *dissimilipes*, but yellow in *cyaneus*. The fore femora are largely black in *dissimilipes* in all the specimens I have seen, they are usually wholly yellow in *cyaneus*, but sometimes a little blackened; the antennæ in this species is usually considerably yellow, still it may be almost black, but in all my specimens of *dissimilipes* it is nearly all black.

I have compared 23 specimens of *dissimilipes* with 43 of *cyaneus* and there does not seem to be any grading except a little in color.

In Dr. Wheeler's large paper on Dolichopodidæ in the Proc. of the Calif. Acad. of Sci., 3d Series, Vol. II, pl. 1, Fig. 21, he gives the drawing of a wing marked in "the explanation of Plate I, as *Pelastoneurus nigrescens*, female, wing," as no species of that name is mentioned by him and as the drawing is a good figure of the wing of *P. dissimilipes*, I think it was no doubt drawn from that species.

Pelastoneurus heteroneurus Macquart.

Female: Length, 4.5 mm. Face very wide and long, covered with brownish gray pollen, which is a little more yellowish below and is thin on upper part so that the metallic green ground color shows through; it is concave on upper portion and convex below; this lower part is longer than the upper, the dividing suture is not conspicuous but distinct, the pollen on the sides of the lower half of the lower portion is whitish. Palpi black with the edges yellow, they are covered with white pollen so as to appear white unless viewed obliquely. Antennæ yellow, third joint very small and mostly blackish; arista black, feathered with long hairs. Front shorter than wide, violet with green reflections in the middle. Orbital cilia wholly black.

Dorsum of thorax greenish black with a narrow violet line on each side of the acrostichal bristles, on the posterior slope these lines are wider and more conspicuous; scutellum green with a median violet line; the dorsum of the thorax is dulled with brownish pollen, which gives it a spotted appearance; pleuræ more green with white pollen. Abdomen green with the last segment violet; it has abundant white pollen, which forms spots on the sides of the segments; the bristles on the hind margin of the last segment are strong.

Fore coxæ yellow, infuscated at base, on the anterior surface the infuscation extends about one-third their length, on the outer surface nearly three-fourths their length, but narrower apically; middle and hind coxæ black with yellow tips; the fore and middle pairs with numerous black hairs. Femora yellow; posterior pair narrowly but sharply blackened at tip except on lower surface. All tibiæ yellow. All tarsi brownish, still the first and second joints more or less yellowish. Calypters and halteres pale yellow, the former with black cilia.

Wings grayish, tinged with brownish in front; last section of fourth vein with its bend near its end and very abrupt, although broadly rounded, this upturned portion only a little more than one-third as long as the straight portion extending from the cross-vein to the bend (Fig. 23) and but little longer than the cross-vein, which is at right angles to it and about as long as the last section of the fifth vein.

Redescribed from one female sent me by C. W. Johnson and taken by him at St. Augustine, Fla., April 19, 1919. Type location, "North America."

This was described from a female by Macquart, in his Dipteres Exotique, Vol. II, Supp. IV, p. 128; and figured on Pl. XII, Fig. 10, as *Dolichopus heteroneurus*. I do not know as it has since been recognized, so I am redescribing it here, his description being rather meager. It is readily recognized by the great distance of the bend in the last section of the fourth vein from the cross-vein, the wholly black orbital cilia and the color of the legs and feet. The form and color of the face and front are also rather distinctive.

Pelastoneurus nigrifacies, sp. nov.

Male: Length, 4 mm.; of wing, 3 mm. Face wide, black, very shining, the suture below the middle; face concave above the suture, convex below; the lower portion has a narrow margin of white, almost silvery, pollen along the lower edge and on the sides, where it widens above at the suture. Palpi blackish with apical half yellowish red and with a few black hairs. Front shining violet on the sides, more black in the middle. Antennæ brown; lower edge of first joint and most of second reddish yellow; third joint rather pointed. Arista feathered with rather long hairs on apical third. Lower orbital cilia white.

Thorax dark green; dorsum dulled with brown pollen and with violet reflections; the ante-alar black spots nearly divided by the green of the dorsum, the white spot at the suture indistinct in described specimen; there is quite a distinct spot of whitish pollen in front of the scutellum; this pollen has a brownish cast when viewed in certain lights. Abdomen dark green with spots of white pollen on its sides. Hypopygium black; its lamellæ long, rounded at tip, fringed with black hairs (they are formed very much as in *vagans* Loew).

Fore coxæ brown, yellow at extreme base and at tip, their anterior surface with black hairs. Middle and hind coxæ black with yellow tips. Femora yellow, posterior pair black at tip, except on lower edge. Tibiæ yellow, anterior pair brownish above, middle ones narrowly black at tip and with three brown rings; posterior ones quite brownish, broadly black at tip and with three darker rings (they are probably sometimes yellow with three brown rings). Fore tarsi blackish from the tip of the first joint, fifth joint (Fig. 9) rather large, with the inner claw elongated and bent back along the lower edge of the joint, which has a small prominence. Middle tarsi black from the tip of the first joint, hind ones wholly black; second joint of hind tarsi only a little longer than the first. Calypters and halteres pale yellow, the former with black cilia.

Wings grayish, veins brown; first section of costa not enlarged; last section of fourth vein a little bent at about the length of the cross-vein from that vein and then gently arched, approaching third at tip (Fig. 8); last section of fifth vein about one and a fourth times as long as the cross-vein.

Described from one male taken at Amates, Gautemala, Jan. 18, 1905. Type in the author's collection.

There are three species with the inner claw of fore tarsi enlarged so as to form a grasping organ. Dr. Aldrich described two of these. *Hamatus* Ald. has the legs and feet almost wholly black, the antennæ are also black and the hypopyginal lamellæ short, in both the other forms the legs are yellow, the antennæ partly yellow, and the lamellæ large. *Nigrifacies*, new species, differs from *unguiculatus* Ald. chiefly in the form and color of the face, but the last section of the fourth vein is a little longer and more arched in *nigrifacies*. The face in *unguiculatus* is conspicuously divided by a longitudinal groove, so that there are two prominant convexites below, the depressed lower part extending up between them as a slender triangle, while in *nigrifacies* the upper part is decidedly concave and extends down as a point in the middle of the face onto the lower part, which is very short, the face not having a trace of a groove or depressed line in the center. The face in *unguiculatus* is opaque with pollen, while in this new species it is shining, polished black both above and below the suture, except that it is narrowly white pollinose along the lower orbits.

Pelastoneurus ramosus, sp. nov.

Male: Length, 3.75 mm.; of wing, 2.75 mm. Face wide, the suture below second third, the upper part with quite a distinct depressed median line, and with a shallow depression across its middle, the lower part but little convex; in the type the face is black with a little gray pollen along the sides and in the sutures (perhaps it has been rubbed). Front blue with yellowish brown pollen along the orbits and above the antennæ; palpi a little infuscated at base, their hairs mostly yellowish. First two antennal joints yellow; third mostly brown, about as long as wide, cut off rather abruptly at tip, so as to make them subquadrate. The orbital cilia appear to be wholly black.

Thorax bronze green, its posterior slope violet, dorsum with gray pollen along the front. Abdomen green. Hypopygium (Fig. 16) black, shining on upper part, it consists of two parts of nearly equal length, the basal part being a little more slender; its lamellæ black, large, wide at base, narrowing rather abruptly into a long curved point, which makes them somewhat sickle-shaped; they are fringed with yellow hairs, which are short on outer, longer on inner edge, especially towards the apex; inner appendages blackish, long, linear, elbowed, each with four yellow bristles which are branched like the limb of a tree.

Fore coxæ wholly yellow with a few small black hairs in the anterior surface; middle and hind coxæ black with yellow tips. Femora and

tibiæ yellow. Fore tarsi about as long as their tibiæ, yellow with the fifth joint black. Middle and hind tarsi infuscated from the tip of the first joint, the latter with the first joint about two-thirds as long as second. Calypters yellow, their cilia yellowish. Halteres yellow, the knob of one black at tip, the other wholly yellow.

Wings uniformly tinged with blackish; first section of costa not thickened; last section of fourth vein rather evenly curved from the cross-vein to its tip; it is furthest from third vein near the middle of its length and approaches third to the tip; last section of fifth vein about as long as the cross-vein, (Fig. 17).

Described from one male taken at Petersburg, Chesterfield Co., Va., June 1, and one male taken at Lafayette, Ind., July 12, 1918, by Dr. J. M. Aldrich.

Holotype in the author's collection.

Pelastoneurus arboreus sp. nov.

Male: Length, 3 mm.; of wing the same. Face wide, upper half gently concave with a depressed median line, and with thin yellowish pollen which does not conceal the ground color; lower half rather flat, with thick yellow pollen; across the middle of the face the pollen is more brown. Palpi covered with thick yellow pollen and with a few black hairs. Front shining violet with a yellowish central space. Orbital cilia wholly black.

Thorax green with violet reflections on the posterior half of the dorsum and dulled with brown pollen; the velvety black line above the root of the wing broad, reaching the suture, where there is a rather large white spot below it; there is another black spot on each side just before the scutellum, which is bronze-green. Abdomen bronze green with white pollen on the sides of the segments, sixth segment covered with thin gray pollen. Hypopygium (Fig. 14) greenish black, pedunculate, not very large, its lamellæ large black, slightly reddish at base, where there are minute yellow hairs below; they are nearly as long as the main portion of the hypopygium, but not quite as wide, somewhat oval in outline, half as broad as long, fringed with long black hairs, which appear pale in certain lights; a pair of long slender appendages above are not quite as long as the lamellæ and have several pale, branched bristles on their lower surface.

Fore coxæ and all femora and tibiæ yellow; middle and hind coxæ blackened on outer surface. Fore tarsi yellow with last joint blackened. Middle and hind tarsi infuscated from the tip of the first joint. Calypters and halteres yellow, the former with black cilia.

Wings dark grayish; last section of fourth vein quite abruptly bent at its middle, ending close to the tip of third vein; last section of fifth vein but little longer than the cross-vein (Fig. 15); the hind margin of the wing slightly indented at tip of fifth vein.

Female: Face with a broad brown stripe, its sides and the palpi with grayish pollen; the lower half conspicuously convex. Fore and middle coxæ black almost to their tips. Thorax with some yellowish brown pollen on the dorsum.

Described from two males and two females. One male which I am making the holotype was taken at Lafayette, Ind., May 25, 1916, by Dr. J. M. Aldrich; the other specimens were taken at Slidell, La., July 2–6, 1905, by J. S. Hine.

Holotype in the collection of J. M. Aldrich.

This is the third species to be described from North America having the inner appendages of the hypopygium long and slender with their bristles branched like the limb of a tree. Dr. Loew described the first form; it was from Texas; this is *furcatus* and has the hypopyginal lamellæ forked and fringed with black hairs. In the other two forms which are described above, the lamellæ are entire, not forked; in *ramosus* the lamellæ are somewhat sickle-shaped and acutely pointed (Fig. 16) and fringed with yellow hairs; in *arboreus* they are oval and scarcely a little pointed at tip, which is somewhat rounded (Fig. 14), and although their hairs appear black in certain lights, still in others they are decidedly yellow.

Pelastoneurus aurifacies, sp. nov.

Male: Length, 2.75 mm.; of wing, 2.5 mm. Face moderately wide, not wider below, its suture nearly at the middle of its length; lower portion rather flat, with a slightly depressed median line and another shorter depressed line on each side in front; upper portion almost golden yellow, the lower part a paler yellow, still somewhat golden. Palpi rather small, covered with white pollen and a few black hairs. Front opaque with brown pollen on lower half, above with a shining blue spot on each side of the ocellar tubercle. Orbital cilia wholly black. First two joints of the antennæ yellow, third mostly brown, yellow only at base. (Arista broken off in type).

Thorax and scutellum shining blue-green, when viewed obliquely the dorsum appears more opaque with yellowish brown pollen; when seen from in front this pollen leaves two shining lines on the dorsum; pleuræ with whitish pollen; the ante-alar black spot and the usual white spot on the suture can scarcely be seen. Abdomen bronze or coppery, rather dull, with spots of white pollen on the sides, last segment wholly covered with whitish pollen. Hypopygium rather short, black, dulled with whitish pollen; its lamellæ blackish, more yellow at base, small, rounded, fringed with a few conspicuous black hairs.

Fore coxæ yellow with black hairs on their anterior surface; middle and hind coxæ black with yellow tips. Femora and tibiæ yellow.

Fore tarsi equal to their tibiæ in length, first three joints yellow, last two black; middle and hind tarsi black from the tip of the first joint, the latter with the first joint about two-thirds as long as the second. Calypters yellow with black cilia. Halteres yellow with the knobs a little brownish.

Wings tinged with brown, the hind margin more grayish; first section of costa not thickened; last section of fourth vein quite abruptly bent, (Fig. 12), the bend being very near its middle; tip, close to the tip of third vein; last section of fifth vein not longer than the cross-vein.

Described from one male which I took at Bradentown, Fla., in March. Type in the author's collection.

Pelastoneurus aldrichi sp. nov.

Male: Length, 4–4.5 mm.; of wing, 3.5–3.7 mm. Face wide, covered with white pollen, which is thin on the upper concave portion, where the metallic ground color shows through more or less; the convex lower part is not as long as the upper portion. Palpi blackish, with yellow margin and black hairs, so thickly covered with white pollen as to appear white when viewed in an oblique direction. Front violet, which color extends onto the upper part of the occuput. Antennæ yellow; third joint about as long as wide, rounded at tip, its apical half brown; arista feathered with rather long hairs. Orbital cilia wholly black.

Thorax violet, more green on the anterior slope and median line; pleuræ black with white pollen; the black line above the root of the wing and the white sutural spot distinct. Abdomen deep violet with the sides below green; sometimes the green is confined to the sides of the first segment; the usual spots of white pollen seem to be confined to the sides of the second, third and fourth segments; most of the small sixth segment covered with white pollen. Hypopygium and its appendages black; its lamellæ rather small, fringed with long black hairs and with a few minute pale ones at their root, there are very small testaceous appendages at their base; inner appendages stout, horn-like, curved and acutely pointed, longer than the lamellæ; at the upper edge of the tip of the hypopygium is a small appendage protruding a little and bearing a brush of short black hairs.

Coxæ and femora black, trochanters, narrow tips of coxæ and base and tip of femora yellow; fore coxæ covered with white pollen and coarse black hairs on anterior surface. Tibiæ yellow, sometimes the posterior pair quite brown, at least at base, the middle ones may also be a little brownish at base; bristles of middle and hind tibiæ usually inserted in brownish spots; apical half of fore tibiæ on anterior surface with a glabrous streak; middle and hind tibiæ almost glabrous above, posterior ones with the upper row of hairs on inner edge distinctly longer than those on outer surface, especially near the tip. Fore tarsi a little longer than their tibiæ, yellow, the upper surface of the three last joints infuscated, their lower surface nearly glabrous and covered

with white pollen; the lower row of hairs on the anterior edge black, close, stiff and rather long. Middle and hind tarsi brown, darker apically, the posterior ones with the second joint considerably longer than the first. Calypters and halteres yellow, the former with black cilia, still it appears quite yellow in certain lights.

Wings grayish (Fig. 3); last section of fourth vein quite abruptly bent near its third fifth; the cross-vein a little more than its length from the wing margin, measured on fifth vein.

Female: Face formed as in the male, with a broad bronze brown stripe in the middle, leaving only a narrow edge of white pollen next the eyes, which is wider below; palpi and antennæ colored as in the male; thorax green with its posterior slope and the scutellum violet; abdomen green, with large spots of white pollen on its sides; coxæ as in the male; femora more or less black, sometimes the posterior pair almost yellow; tibiæ as in the male; fore tarsi colored as in the male, about as long as their tibiæ; middle and hind tarsi black from the tip of the first joint, second joint of the latter but little longer than the first; cilia of the calypters and the wings as in the male.

Described from sixteen males and eleven females taken by by Dr. J. M. Aldrich in Utah; nineteen were taken at Brigham, July 4, 1911, and seven at Salt Lake City, July 18–20, 1917.

Holotype and Allotype in the collection of J. M. Aldrich.

I am pleased to dedicate this interesting and distinct species to Dr. Aldrich, who took the type specimens and who has described so many of our species in this genus.

Pelastoneurus caeruleus sp. nov.

Male: Length, 4 mm.; of wing, the same. Face wide, with the suture not quite half way down, making the concave upper portion scarcely as long as the convex lower part; above it is bright metallic green, the lower part thickly covered with white pollen. Palpi blackish with yellow apical margin, its hairs black. Front violet with the edges narrowly green. Antennæ yellow; third joint short, rounded and blackened at tip; arista feathered with long hairs. Lateral and inferior orbital cilia whitish, about eight of the upper cilia on each side black.

Dorsum of thorax dark violet, with green reflections and a median steel-blue vitta, its anterior slope more bronze; pleuræ blackish with white pollen, dorsum with thin brownish pollen, which is more conspicuous on the posterior slope; the black spot above the root of the wing narrow, but reaching the suture, where there is a conspicuous white spot below it. Abdomen green with spots of white pollen on its sides, sixth segment almost wholly white pollinose. Hypopygium green, rather thick and large; its lamellæ slender, black, extending upwards and outward, they are a little yellow at base where they have small, yellow-haired, yellow, lamellæ-like appendages, extending beyond these are two thick yellow inner appendages which have a slender black bristle below near the middle of their lower edge.

Fore coxæ yellow, a little blackened at extreme base and with black hairs on their anterior surface; middle and hind coxæ black with yellow tips. Femora and tibiæ yellow; middle tibiæ with a pair of bristles below near their middle. Fore tarsi about one and a third times as long as their tibiæ, almost wholly yellow. Middle and hind tarsi mostly brownish.

Wings dark grayish; last section of fourth vein bent at its middle; last section of fifth vein about as long as the cross-vein; anal angle rounded, not very prominent.

Female: Almost like the male, except that the fore tarsi are but little longer than their tibiæ.

Described from three males and two females taken at Santa Lucia, Gautemala, February 2. I received these specimens from Prof. James Hine.

Holotype and Allotype in the author's collection.

This is very much like *argantifer* Ald., agreeing in the form and color of the face and hypopyginal lamellæ and in the venation of the wings, but differ in having the inner hypopyginal appendages yellow with a black bristle below; in *argantifer* these appendages are black and have no bristle below, but have a long, curved, black bristle at base which is not found in this species. This form also has one black bristle at the lower end of the orbital cilia, while *argentifer* has no black bristle on the lower part of the head.

Pelastoneurus costalis sp. nov.

Female: Length, 4 mm.; of wing the same. Face wide, covered with grayish white pollen, which is a little brownish in the center, the green ground color shows through a little on the concave upper portion, which is decidedly shorter than the convex lower part. Antennæ yellow, the upper edge of the first joint and most of the third joint black; arista feathered with long hairs. Front shining, almost black, still with slight blue reflections; orbital cilia white with about ten of the upper ones on each side black.

Thorax very dark green, dorsum dulled with brown pollen; the usual black spot above the root of the wing rather narrow, but reaching the suture; the white spot at the suture large, reaching the humeri; pleuræ with white pollen. Abdomen green, the hind margins of the segments black; the spots of white pollen on the sides of the segments large.

All the coxæ black, a little yellow at tip. Femora and tibiæ yellow, tips of hind femora above and tips of all tibiæ black. Fore tarsi blackened almost to their base; middle and hind tarsi black from the tip of the first joint. Calypters and halteres yellow, the former with black cilia.

Wings (Fig. 22) dark grayish; costa much enlarged before the tip of the first vein, especially when viewed from the front of the wing; last section of fourth vein gently arched from the cross-vein to its tip, which is close to the tip of third vein.

Described from one female which was taken at Atoyac, Vera Cruz, May. Type in the collection of J. M. Aldrich.

An interesting form, it being the only species in the genus known to me with enlargement of the costa. It is the third species we have with black fore coxæ where the lower orbital cilia is pale, the others being *vagans* Loew; and *occidentalis* Wheeler.

Pelastoneurus insulanus sp. nov.

Male: Length, 3 mm.; of wing, 2.5 mm. Face rather wide, covered with white pollen, upper half slightly concave with a depressed median line, lower half a little convex. Palpi black with black hairs. Front violet. Occiput green. Antennæ reddish yellow, rather large; third joint a little longer than wide; arista feathered with rather long hairs. Orbital cilia whitish.

Dorsum of thorax brown, a little shining, the black spot above the root of the wing narrow but distinct, the silvery white spot at the suture conspicuous; scutellum bronze-green, its center deep black; pleuræ greenish. Abdomen blackish with large spots of white pollen on the sides of the segments. Hypopygium and its lamellæ black; lamellæ elongate, ribbon-like, fringed with long black hairs, their base yellow, oval and fringed with yellow hairs; inner appendages blackish, small, lamellæ-like.

Fore coxæ yellow, a little infuscated at base on outer side; middle and hind coxæ black with yellow tips. Femora and tibiæ yellow; hind femora black at tip on upper edge. Fore and middle tarsi a little longer than their tibiæ, yellowish brown, darker at tip. Calypters and halteres yellow, the former with black cilia.

Wings tinged with brownish; last section of fourth vein bent at its middle, so as to approach third at tip (Fig. 20); cross-vein one and a fourth times its length from the wing margin, measured on fifth vein.

Described from one male taken by Baker at Havana, Cuba. Type in the collection of Dr. J. M. Aldrich.

Pelastoneurus nigricornis sp. nov.

Male: Length, 4 mm.; of wing the same. Face wide, covered with silvery gray pollen, the upper portion above the suture shorter than the lower part. Palpi black with yellow edges and whitish pollen. Front green, more blue near the orbits. Antennæ wholly black; third joint about as long as wide, rounded at tip; arista feathered with long hairs. Orbital cilia wholly black.

Thorax green, with violet reflections on the posterior half of the dorsum; the black spot reaching from the root of the wing to the humeri is narrow and not conspicuous, there is a spot of whitish pollen above the root of the wing and a large one below at the suture, but these spots are not glistening white as in some species; scutellum green, more blue on the median line and on the margin. Abdomen green with large spots of white pollen on the sides of the segments; sixth segment wholly white pollinose. Hypopygium black; its lamellæ oval, testaceous, not large, fringed with rather long, black hairs on their edges, which are blackish, their sides nearly bare. The inner appendages are somewhat thickened and nearly as large as the lamellæ; above these at upper apical corner of the hypopygium are small appendages with short hairs at tip.

Coxæ black, with narrow yellow tips, fore coxæ covered with snow white pollen and black hairs on their anterior surface. Fore femora blackened on basal half; middle ones blackened on upper and lower edges at base and hind ones at tip on upper edge; fore and middle tibiæ, fore tarsi and first joint of middle tarsi, except extreme tip, rather pale yellow, remainder of middle tarsi black. Fore tarsi nearly bare below where they have a little white pollen. Hind tibiæ and base of their tarsi brownish yellow. Middle tibiæ with two bristles below, one before the middle and one near apical third. Calypters and halteres yellow, the former with black cilia.

Wings (Fig. 1) about as in *P. dissimilipes* Wh. They are nearly hyaline; only a little grayish.

Described from one male, taken at Atherton, Mo., August 12, 1901.

Type in the collection of Dr. J. M. Aldrich.

This is almost like *dissimilipes* Wh. The venation, antennæ, face and general color are the same; the hypopyginal lamellæ are somewhat different, although at first sight they might be thought to be alike, they differ, however, in the lamellæ, being a little smaller and more oval, not at all triangular, and also in having their outer surface bare or nearly so; while in *dissimilipes* the outer surface is covered with long black hairs, as well as their edges; this form also has large inner appendages which are not found in *dissimilipes*. In the type specimen the small appendages at upper apical corner of the hypopygium has only short hairs at tip as far as I can see, but the similar appendages in *dissimilipes* have long hairs at tip. In this species the fore and middle tibiæ and fore tarsi are not at all infuscated in the single specimen before me, while in *dissimilipes* they are quite black in all my specimens. Both species differ from *cyaneus* Wh. in the venation of the wings, Fig. 10 being that of *cyaneus* and Fig. 1 is that of *nigricornis*, and also about as that of *dissimilipes*.

Pelastoneurus tibialis new species.

Male: Length, 4 mm. Face wide, silvery white, suture above the middle. Palpi blackish with silvery pollen and black hairs. Front bronze brown or blackish, rather dull. Antennæ black, first and second joints slightly yellowish at tip below; third joint scarcely as long as wide, rounded at tip; arista as long as the antenna, feathered with long hairs. Orbital cilia wholly black.

Thorax bronze brown with brown pollen, sometimes it has green or violet reflections or stripes on the dorsum; there are no black dots at the root of the bristles, at least none that are conspicuous; pleuræ black with a little silvery pollen. Scutellum bronze colored. Abdomen green with bronze reflections. Hypopygium black; lamellæ shining black, somewhat triangular, convex on outer surface, with black hairs on the edges and on the outside of apical half, inner appendages a little yellowish, not conspicuous; upper outer angles of the hypopygium with several bristles, but not prolonged.

Coxæ black with narrow yellow tips; anterior pair with silvery pollen and black hairs on the front surface. Fore femora black with apical third and extreme base yellow; middle ones mostly black on basal half; posterior pair yellow with the tip slightly brownish above. Fore tibiæ yellow, usually a little blackened at base above, middle tibiæ wholly black (in one specimen they are yellow with a black tip and base). Hind tibiæ yellow with the base and sometimes the tip black. Middle tibiæ with two bristles near the lower surface besides those on upper side. Fore tarsi yellow, as long as their tibiæ, first joint as long as the three following joints taken together, fourth joint the shortest. Middle and hind tarsi black from the tip of the first joint, the latter with the first and third joints of nearly equal length, second considerably longer. Calypters, their cilia and halteres yellow.

Wings grayish; venation about as in Figure 1, except that the last section of the fifth vein is less curved.

Female: Colored about as in the male, except the legs and face. Face brownish, with the sides quite widely whitish and the lower edge shading into grayish. Femora and tibiæ yellow. Tarsi about as in the male. Cilia of the calypters black with several of the upper hairs white.

Described from three males and one female taken by Mr. C. F. Adams, at Jemezsprings Mts., New Mexico, in June.

This is very near *dissimilipes* Wheeler. The male differs in the color of the tibiæ, and the hypopygium does not seem to have any appendages on the upper outer corners as in *dissimilipes*, but only a few bristle-like hairs. The female differs in having the first and second joints of the antennæ distinctly yellow below; the face is grayish, especially below, and the white pollen on the sides of the face is considerably wider.

Pelastoneurus dorsalis new species.

Male: Length, 4 mm. Face wide, covered with silvery white pollen, its suture above the middle; upper portion a little concave with a median, longitudinal, depressed line; lower part convex with the oral margin rounded. Palpi black, with yellow edge and black hairs. Front green with blue and bronze reflections. Antennæ black with first joint a little yellow below; third joint about as long as wide, rounded. Arista as long as the antenna, feathered with rather long hairs. Orbital cilia wholly black.

Thorax green, dorsum with purple reflections; the black stripe above the root of the wings is not conspicuous, the spot of white pollen at the suture large; humeri with a little white pollen; there are stripes of white pollen, which has a greenish shade in certain lights, along the lines of dorsocentral bristles, these lines are broken into spots by the black dots at the insertion of the bristles; on each side of the acrostichal bristles is a purplish brown line; scutellum green, with a depression on each side of the median line. Abdomen green with the incisures metallic brown, its hairs long and black; it is dulled with white pollen, which forms large spots on the sides of the segments; last segment wholly silvery pollinose; fifth segment with a row of long, black bristles on its hind margin. Hypopygium black, with a very short peduncle; it has a patch of black hairs on the left side at base; lamellæ rather large, shining black, still a little dulled with white pollen, fringed with rather long, slender, brown hairs.

Coxæ black with silvery white pollen; anterior pair with the extreme tips yellow, hairs on anterior surface and bristles at tip black. Fore femora black on basal half, yellow on apical half; middle ones yellow with their lower edge a little blackened and with a row of black hairs on their lower anterior edge, which are not very long. Hind femora wholly yellow, with a large preapical bristle above and stiff black hairs on lower outer edge, which are longer apically, the last ones bristle-like. All tibiæ yellow; middle pair with two rather small bristles on lower anterior edge; extreme tip of middle pair and extreme base and tip of hind ones a little blackened, the latter with the two rows of bristles above large and with a glabrous line between them; they have no bristle below. Fore tarsi about as long as their tibiæ, infuscated from the tip of the first joint, which is as long as the following three taken together; third and fifth of equal length, fourth slightly shorter. Middle tarsi longer than their tibiæ, black from the tip of the first joint and with the fourth and fifth joints of equal length. Hind tarsi longer than their tibiæ, yellowish at base, becoming black at tip; first and third joints of equal length, second longer. Calypters, their long delicate cilia and the halteres yellow.

Wings grayish; last section of fourth vein about as in *arboreus* (Fig. 15), but the last section of fifth vein is not so much bent; anal angle rounded.

Described from one male taken at San Evaristo, Lower California, June 10, 1921, by Edward P. Van Duzee.

Type in the collection of the California Academy of Sciences.

Pelastoneurus barbicauda new species.

Male: Length, 3.2 mm.; of wing, 2.7 mm. Face rather wide, silvery white, its suture near the middle, upper portion with a depressed median line, lower part convex, its lower edge nearly straight, but little rounded. Palpi black with yellow edges, black hair and white pollen. Antennæ yellow; third joint largely brown, rounded; arista feathered with long hairs. Front blue with the upper edge violet, lower half covered with brown pollen. Orbital cilia wholly black.

Dorsum of thorax metallic brown, dulled with brown pollen; posterior slope violet, but with a green space in the middle before the scutellum; the velvety black stripe above the root of the wing distinct and quite wide; there is a round spot of silvery white pollen at the suture and another smaller one above the root of the wing; pleuræ green with white pollen; scutellum coppery. Abdomen green with black hairs and thin white pollen, which forms rather small spots on the sides of the segments; fifth segment with a row of long black bristles on its posterior margin. Hypopygium greenish with the usual patch of black hairs on the left side at base; lamellæ rather large, shining black with the stem a little yellowish at root, where there are short yellow hairs, outer part rounded and covered with long, stiff, black hairs on both edge and disk.

Coxæ black with yellow tips, silvery white pollen and black hair and bristles. All femora yellow, without longer hair below; middle pair with one preapical bristle, posterior ones with two preapical bristles, one above and one below on outer surface, and are black above at extreme tip. All tibiæ yellow; posterior pair slightly infuscated at extreme tip and on upper edge of extreme base. Middle and hind tibiæ with one large bristle on lower anterior surface. Fore and middle tarsi about as long as their tibiæ, with their first joint a little longer than the two following taken together; anterior pair mostly yellowish, stout and rather hairy, third and fifth joints of equal length, fourth slightly shorter; middle tarsi black from the tip of the first joint, with fourth and fifth joints of equal length. Hind tarsi wholly black, still the first joint is slightly yellowish at base, first joint slightly shorter and the second longer than third. Calypters and halteres yellow, the former with long black cilia.

Wings grayish (Fig. 18); last section of fourth vein bent beyond its middle. Anal angle of wing rounded.

Female: Color and tarsi as in the male, except that the face is brown with its edges narrowly silvery white. The fore coxæ are largely yellow on inner and anterior surfaces; the wings are more tinged with brown than in the male.

Described from two males and three females; two pair were taken at San Evaristo, Lower California, June 10, 1921, and one female taken at Loreto, Lower California, May 19, 1921, by Edward P. Van Duzee.

Type in the California Academy of Sciences.

TABLE OF SPECIES

FOUND IN AMERICA NORTH OF CENTRAL AMERICA, AND FROM THE WEST INDIES.

MALES.

1. Femora black, at least one pair largely black....2
   Femora yellow, the tip of the hind pair or the upper edge may be black....8
2. Half, or more than half, of the fore femora black; middle ones black at base; hind ones yellow with or without a black tip; wings about as in figure 1....3
   All femora and tibiæ almost wholly black....7
3. All tibiæ black or considerably infuscated, hind ones always black, (Calif.)....*dissimilipes* Wheeler.
   Anterior and posterior tibiæ largely yellow....4
4. Hind femora wholly yellow....5
   Tip of hind femora black....6
5. Middle tibiæ wholly yellow; thorax green with purple reflections and conspicuous black spots at base of dorso-central bristles, (Lower California)....*dorsalis*, new species.
   Middle tibiæ wholly black or spotted with black; thorax bronze brown with green reflections, without noticeable spots at base of bristles, (New Mexico)....*tibialis*, new species.
6. Cilia of the calypters black, (Missouri)....*nigricornis*, new species.
   Cilia of the calypters whitish, (New Mexico)....*tibialis*, new species.
7. Antennæ almost wholly black; inner claw of fore tarsi much enlarged, wing as in figure 2, (Mexico)....*hamatus* Aldrich.
   Antennæ reddish yellow with the third joint black; claws of fore tarsi normal, wing as in figure 3, (Utah)....*aldrichi*, new species.
8. Wings with one or more brown spots or clouds, other than those that may be on the veins....9
   Wings without spots, except sometimes on the cross-vein and on the middle of last section of fourth vein....11
9. Wings with a rounded, but not very sharply defined, apical spot, as in figure 4, (Mexico)....*bigeminatus*, Aldrich.
   Wings with numerous spots in the cells....10
10. Last section of fourth vein uniformly approaching third towards its tip, figure 5, (Mexico)....*punctipennis*, Say.
    Last section of fourth vein abruptly bent towards third at a point beyond its middle, figure 6, (Florida)....*pictipennis*, Wheeler.
11. Thorax with a more or less conspicuous spot of white pollen before the scutellum, which is best seen when viewed from behind. Hypopyginal lamellæ blackish....12
    Thorax without such a spot, or the pollen forming it more brown....15
12. Hypopyginal lamellæ rather small; last section of fourth vein abruptly bent at its middle; claws of fore tarsi normal....13
    Lamellæ rounded at tip, long; last section of fourth vein only slightly arcuated, approaching third from the cross-vein, about as in figure 8; inner claw of fore tarsi enlarged as in figure 9....14
13. Antennæ black with first joint narrowly yellow below, (N. Y., Fla., Calif.)....*longicauda*, Loew.
    Antennæ yellow with apical half of third joint blackened, (Lower California)....*barbicauda*, new species.
14. Face covered with white or brownish pollen, (W. I., Mex., C. R., Guatemala)....*unguiculatus*, Aldrich.
    Face black, very shining, with only a narrow border of white pollen on the lower portion of the orbits, (Guatemala)....*nigrifacies*, new species.
15. Orbital cilia wholly black....16
    Inferior orbital cilia pale....30
16. Fore coxæ black, more or less yellow at tip....17
    Fore coxæ yellow, sometimes a little blackened at base....20

17. Abdomen dark green or bronze-green; coxæ almost wholly black..... 18
Abdomen deep violet.....19
18. Outer hypopyginal lamellæ somewhat crescent-shaped, inner appendages with long, delicate, pale hairs; first and second antennal joints black above, (N. Y., Fla.).....*abbreviatus*, Loew.
Outer lamellæ large, almost round with a short stem; inner appendages almost bare; first and second antennal joints wholly yellow, (Lower California).....*barbicauda*, new species.
19. Bend in last section of fourth vein near apical third, figure 10, (Calif., Mex., Nev., Ariz., S. D.).....*cyaneus*, Wheeler.
Bend in last section of fourth vein at its middle, figure 7, (Fla., N. Y., Calif.).....*longicauda*, Loew.
20. Hypopyginal lamellæ divided, forming four long filaments, (Kansas). *kansensis*, Aldrich.
Hypopyginal lamellæ of different structure, blackish.....21
21. Hypopyginal lamellæ small, rounded, or crescent-shaped.....22
Lamellæ large, somewhat pointed at tip.....25
22. Face with a more or less distinct brown line or band; dorsum of thorax rather opaque, brown; wing as in figure 11, (N. Y., Ill., Fla., Mex.). *lugubris*, Loew.
Face of male without brown band or line; dorsum of thorax shining.....23
23. Face thickly covered with yellow pollen, wings as in figure 12, (Florida). *aurifacies*, new species.
Face with white pollen, the bluish ground color sometimes showing through on upper portion.....24
24. Hypopyginal lamellæ rounded, with short black hairs on the edge and minute yellowish ones on the surface, wing as in figure 13, (La., Fla., Ga.).....*parvus*, Loew.
Lamellæ somewhat triangular or crescent-shaped, with long black hairs, (N. Y., Mass.).....*lamellatus*, Loew.
25. Inner appendages of the hypopygium slender, with long branched bristles.....26
Inner appendages with their hairs and bristles simple.....28
26. Hypopyginal lamellæ furcate, (Texas).....*furcifer*, Loew.
Lamellæ entire, not at all forked.....27
27. Hypopyginal lamellæ somewhat oval in outline, still obtusely pointed at tip; face with yellow pollen; see figures 14 and 15, (Ind., La.) *arboreus*, new species.
Lamellæ more sickle-shaped, quite acutely pointed at tip; face silvery white; see figures 16 and 17, (Va., Ind.).....*ramosus*, new species.
28. Face with brown pollen, (Louisiana).....*proximus*, Aldrich.
Face with white pollen.....29
29. Hypopyginal lamellæ narrow, gently bent upwards at tip, (Fla., Ga., La., D. C.).....*laetus*, Loew.
Lamellæ produced into a curved, stout, black, horn-like point, which is longer than the lamella, (Quebec).....*falcatus*, Aldrich.
30. Fore coxæ blackened on basal half or more; hypopygial lamellæ long....31
Fore coxæ wholly yellow, or nearly so.....32
31. Hypopyginal lamellæ rounded at tip, all their hairs black, (see figures 18 and 24), (N. America; Mexico).....*vagans*, Loew.
Lamellæ pointed at tip (fig. 25), their hairs largely yellowish, (Calif., Ore.).....*occidentalis*, Wheeler.
32. Hypopyginal lamellæ largely blackish.....33
Lamellæ largely yellow or whitish; upper half of the hypopygium and its tip yellow.....39
33. Upper half of face shining green.....34
Face wholly opaque with pollen.....35
34. Lamellæ of the hypopygium long and narrow with minute yellow appendages at base, between those and projecting beyond them are what seem to be the inner appendages; they are thick and shining black with a long black bristle at base, (W. I., Mex., Guatemala). *argentifer*, Aldrich.

Lamellæ as above; inner appendages formed as above, but yellow and without the bristle at base, still there is a bristle on their lower edge near the middle which is not found on the proceeding species, (Guatemala)..... *caeruleus*, new species.

35. Thorax with a small glistening white dot in the sutural groove, (Eastern States, Mexico)..... *cognatus*, Loew.
The white spot at the sutural groove larger, sometimes indistinct.....36
36. Hypopyginal lamellæ long and strap-like.....37
Lamellæ not at all strap-like.....38
37. All coxæ yellow, still the middle and hind ones a little darkened at base, (Island of St. Jean)..... *taeniatus*, Becker.
Fore coxæ yellow, a little blackened at base; middle and hind coxæ black with yellow tips; the long strap-like lamellæ have a very small, oval, yellow base which is fringed with small yellow hairs. Wing as in figure 20, (Cuba)..... *insulanus*, new species.
38. Hypopyginal lamellæ short, rounded, (Florida)..... *floridans*, Wheeler.
Lamellæ ax-shaped, (Georgia)..... *asciaeformis*, Becker.
39. Antennal arista long, not tapering, its tip rather blunt, (Wis., Ill., N. Y., La.)..... *neglectus*, Wheeler.
Arista normal, tapering to a fine point.....40
40. Abdomen shining steel-blue; pollen of the face wholly white, (West Indies)..... *fasciatus*, Roeder.
Abdomen green; upper half of face with its pollen almost golden yellow; wing as in figure 21, (Tex., Ga., Calif.)..... *wheeleri*, Melander.

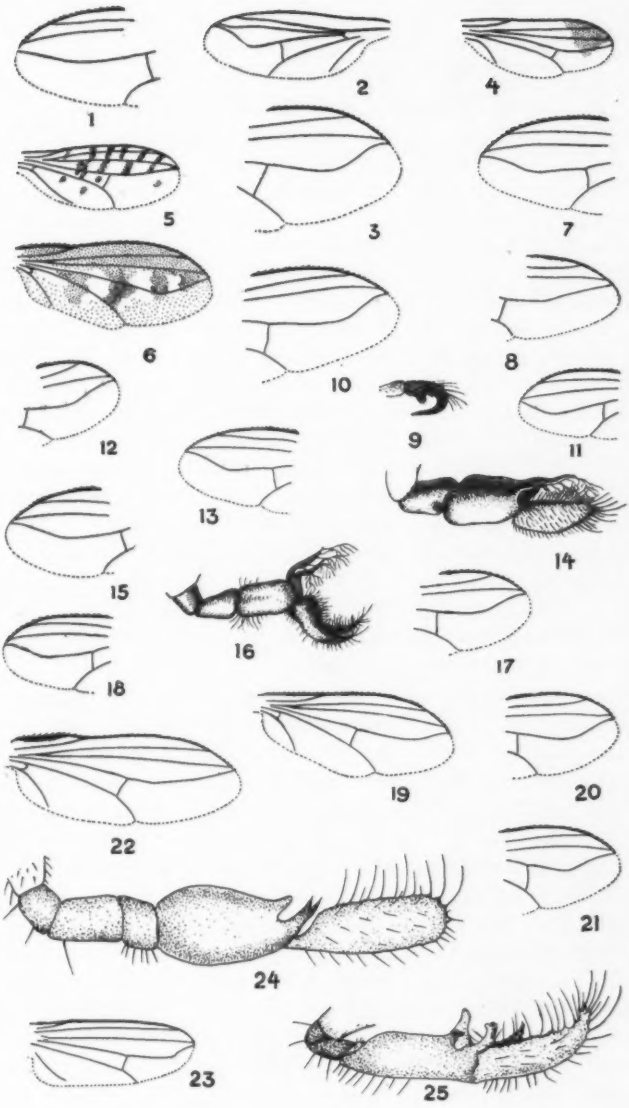
FEMALES.

1. Femora black, at least one pair largely black.....2
Femora yellow, the tip or upper edge may be blackened.....3
2. Face with yellow pollen, which may be thin on upper portion; antennæ black, except the lower edge of first joint..... *hamatus*, Aldrich.
Pollen of the face brown, except a narrow line of white on each side; upper portion of face green in the center; antennæ mostly yellow. *aldrichi*, new species.
3. Wings with numerous spots or clouds in the cells.....4
Wings with one to three spots, which are sometimes small and placed on the veins.....5
Wings unspotted, but sometimes with the front margin more or less tinged with brown.....7
4. Last section of fourth vein abruptly bent towards third, at a point beyond its middle, (fig. 6)..... *pictipennis*, Wheeler.
Last section of fourth vein uniformly approaching third towards its tip, (fig. 5)..... *punctipennis*, Say.
5. Wings with a faint cloud at tips of third and fourth veins (about as in figure 4); the usual silvery spot at the suture is yellow in this species *bigeminatus*, Aldrich.
Wings with a brown spot on the middle of the last section of the fourth vein and another on the cross-vein and near the root of the wing. *umbripictus*, Becker.
6. Fore coxæ black, at least considerably blackened at base.....7
Fore coxæ yellow; there may be a blackish spot at base on outer surface....18
7. Thorax with a more or less distinct spot of white pollen before the scutellum, best seen when viewed from behind.....8
Thorax without such a spot of pollen.....10
8. Last section of fourth vein rather abruptly bent near its middle, as in figure 7..... *longicauda*, Loew.
Last section of fourth vein gently arched from the cross-vein to its tip, which is near the tip of third vein, about as in figure 8.....9
9. Antennæ yellow below..... *unguiculatus*, Aldrich.
Antennæ wholly black..... *dissimilipes*, Wheeler.
10. Orbital cilia pale below.....11
Orbital cilia wholly black.....12

11. Wing with the costa very conspicuously enlarged before the tip of the first vein, (fig. 22).....*costalis*, new species.
Costa not at all thickened.....*occidentalis*, Wheeler; *vagans*, Loew.
12. Fore coxæ almost wholly black.....13
Fore coxæ blackened at base nearly to the middle.....16
Fore coxæ a little blackened at base in front, their outer surface nearly half blackish.....17
13. Last section of fourth vein gently arched, not bent, about as in figure 8....14
Last section of fourth vein with a distinct bend, which is quite abrupt.....15
14. Face brown, the brown reaching the lower edge, narrowly white on the sides.....*dissimilipes*, Wheeler.
The brown of the face shading into gray below, face broadly white on the sides.....*tibialis*, new species.
15. Bend in last section of fourth vein near its middle; base of fore femora usually infuscated, (eastern species).....*abbrevialus*, Loew.
Bend in last section of fourth vein near its apical third, (western species). *cyaneus*, Wheeler.
16. Hind tibiæ largely infuscated; wing as in figure 11.....*lugubris*, Loew.
Hind tibiæ wholly or almost wholly yellow.....*lamellatus*, Loew.
17. Bend in last section of fourth vein nearly three times as far from the cross-vein as the length of that vein.....*heteroneurus*, Macquart
Bend in last section of fourth vein at or very near its middle. *barbicauda*, new species.
18. Orbital cilia wholly black.....19
Orbital cilia pale below.....21
19. Face wholly covered with white pollen; wing as in figure 13..*parvus*, Aldrich.
Pollen of the face brown, except a narrow line of white along the orbits....20
20. Middle and hind coxæ with apical half yellow.....*proximus*, Aldrich.
Middle and hind coxæ with apical third yellow.....*falcatus*, Aldrich.
Middle and hind coxæ almost wholly black; wings as in figure 15. *arboreus*, new species.
21. Upper half of face concave, shining green with little pollen; lower half convex, opaque with grayish white pollen, which is more brown near the suture.....22
Face wholly opaque with pollen, or nearly so.....23
22. Inferior orbital cilia yellowish with one or two black bristles next to the proboscis.....*caeruleus*, new species.
Lower part of the head without a black bristle, those near the proboscis wholly yellowish.....*argentifer*, Aldrich.
23. Arista long, tapering but little, its tip blunt.....*neglectus*, Wheeler.
Arista normal, tapering to a point.....24
24. Abdomen with the hind margins of the segments conspicuously blackened?.....*fasciatus*, Roeder.
Hind margins of the abdominal segments narrowly black as usual.....25
25. Upper portion of the face with yellow pollen.....*wheeleri*, Melander.
Pollen of the face brown on the center, white on the sides.....26
26. The brown pollen of the face reaches the lower edge, white pollen on the sides narrow; thorax with the sutural spot of white pollen large. *floridanus*, Wheeler.
The brown of the face narrow, and not reaching the lower edge; thorax with the sutural spot small, glistening white, round, dot-like*cognatus*, Loew.

EXPLANATION OF PLATE I.

Fig. 1. nigricornis, new species, tip of wing.
Fig. 2. hamatus, Aldrich (after Aldrich). Wing.
Fig. 3. aldrichi, new species, tip of wing.
Fig. 4. bigeminatus, Aldrich, (after Aldrich). Wing.
Fig. 5. punctipennis, Say. Wing.
Fig. 6. pictipennis, Wheeler. Wing.
Fig. 7. longicauda, Loew. Tip of wing.
Fig. 8. nigrifacies, new species, tip of wing.
Fig. 9. nigrifacies, new species, fifth joint of fore tarsus of male.
Fig. 10. cyaneus, Wheeler. Tip of wing.
Fig. 11. lugubris, Loew. Tip of wing.
Fig. 12. aurifacies, new species, tip of wing.
Fig. 13. parvus, Aldrich. Tip of wing.
Fig. 14. arboreus, new species, hypopygium of male.
Fig. 15. arboreus, new species, tip of wing.
Fig. 16. ramosus, new species, hypopygium of male.
Fig. 17. ramosus, new species, tip of wing.
Fig. 18. vagans, Loew. Tip of wing.
Fig. 19. cognatus, Loew. Tip of wing.
Fig. 20. insulanus, new species, tip of wing.
Fig. 21. wheeleri, Melander. Tip of wing.
Fig. 22. costalis, new species, wing.
Fig. 23. heteroneurus, Macquart. Wing, (after Macquart).
Fig. 24. vagans, Loew. Hypopygium of male.
Fig. 25. occidentalis, Wheeler, hypopygium of male.



M. C. Van Duzee

THE WAX SECRETING GLANDS OF PSEUDOCOCCUS CITRI RISSO.

By Robert Matheson,
Cornell University.

Wax secreting glands are found in a large number of insects scattered throughout the various orders. Though the secreted product varies greatly in composition and the uses very diverse yet, so far as known, all wax glands are epidermal in origin and usually more or less closely connected with the exterior. The most noted groups of wax producing insects are the Aphididæ and Coccidæ. So important is it in some of the Coccidæ that very large industries are based upon the product—i. e., lac produced by the lac insects (*Tachardia lacca*, *Gascardia* (*Ceroplastes*) *madagascarensis*, etc.). Lac is a resinous product which in the case of the *Gascardia* product consists of about 28.5% wax and 52.5% resin, while the lac of *Tachardia lacca* contains 68% resin and only 6% wax. The animal value of the Indian product now exceeds $20,000,000 and a great deal of experimental work is being done in the cultivation and improvement of the lac industry in India.

Wax production also occurs in other hemipterous families as Fulgoridæ, Cicadidæ, Notonectidæ, etc., in the Lepidoptera, (*Retinia* sp.), Coleoptera (Rhyncophora), and Hymenoptera (*Tenthredinidæ*, *Apidæ*, *Bombidæ*).

Our knowledge of the wax producing glands is very limited and consists of a few isolated papers written in various languages. Berlese (1893), Visart (1894 and 1895), and Sulc (1909) are the principal contributors on the wax glands of Coccidæ and Aphididæ. As this paper does not deal with wax glands in general, I shall restrict myself to a discussion of the glands as found in Coccidæ, more particularly *Pseudococcus* species. In discussing the various types of glands reference will be made to the work of the above mentioned authors, especially where I differ from them in the interpretation of structure and types of glands.

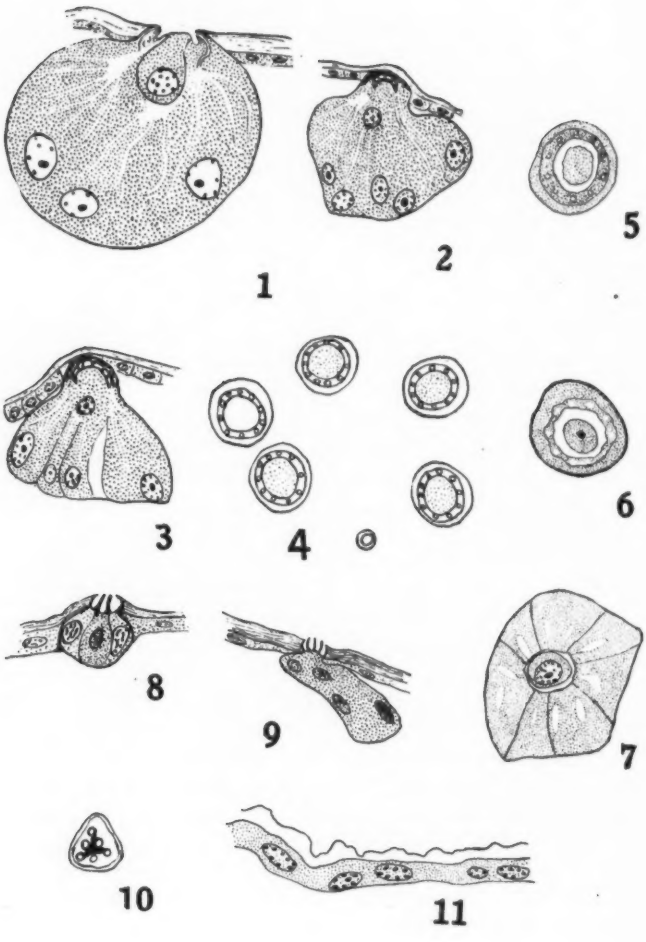
Pseudococcus citri, one of the common species of mealy bugs, is well known. The name mealy bugs undoubtedly refers to the mealy, waxy secretion which covers the entire body, and extends in beautiful lateral and caudal pencils. In this species there are seventeen such pencils, three on the head, two on each thoracic segment and one on each of the eight abdominal segments. In addition to these pencils the entire body is covered by a fine waxy powder and the females produce a loose waxy filamentous sac in which the eggs are laid. All this wax and waxy threads are produced by various types of epidermal wax glands. Fig. 11 shows the normal epidermal structure.

THE WAX GLANDS.

There are several distinct types of wax glands. I shall discuss each type separately and endeavor to indicate the precise product produced by each type.

TYPE I. This is a large, multicellular gland. (Figs. 1, 2, 3). It is found most abundant on the posterior ventral and lateral portions of the body, particularly about the opening of the oviduct. It also occurs around the cerarii and scatteringly over the ventral and lateral margins of the body. Viewed in toto this gland appears shaped like an erlenmyer flask with a short neck. The number of cells composing it undoubtedly varies though it would seem to run from seven to eleven. There is always a central cell which forms a sort of stopper and around which the others are arranged. The external opening of this gland is rather remarkable. Viewed from the external it is a circle, a chitinous ring, through which a number (usually 10) openings are found (Fig. 4). The center of this ring is closed by the cuticula of the central cell. In sections the minute pores can be traced directly back into the cells and undoubtedly they are the exits for the secretion. In actively secreting cells these pores gradually enlarge as we proceed into the gland. This condition is well shown in Figs. 5, 6 and 7.

As this type of gland is very abundant about the genital opening they undoubtedly secrete much of the waxy threads which form the egg sac. The type of thread they secrete, in the writer's opinion, is shown in Fig. 20. (The short coiled threads.)



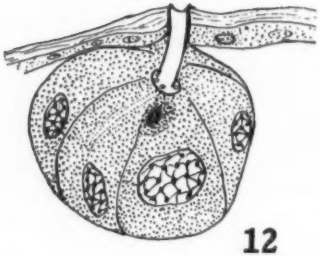
Robert Matheson

TYPE II. This gland is even more remarkable than the preceding. It does not occur in such abundance, but is always found associated with it. It also resembles a flask, but with a long chitinous neck and an entirely different type of external opening. Like the former it always possesses a central cell closely associated with the exit tube (Fig. 12). The exit tube is a chitinous cylinder extending down into the gland. According to Visart (1894) the proximal end of the tube is closed. The external opening is a minute circle appearing in the chitin (Fig. 4, the small figure). This gland is composed usually of from six to ten cells. It is supposed to secrete the long, large threads of the lateral filaments and the ovisac. Visart states that the contents of the cells pass through this chitinous cylinder where it hardens and then passes out as a thread. I do not agree with this. I have been able to demonstrate again and again minute pores around the base of this chitinous cylinder. I believe the secretion of these cells is poured through these pores and the cylinder forms the mold in which the thread takes shape. It is gradually pushed to the exterior by the pressure behind. Within the cylinder the secretion hardens into a thread so that the excreted product is a continuous flexible thread. When this gland is secreting actively a large central area is filled with the product (Figs. 13 and 14) and the wax thread can be seen in sections extruding from the external opening.

This gland is always associated with Type I, but is not so abundant.

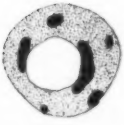
TYPE III. This is a much smaller gland and is found all over the insect. Like the others, it consists of a central cell surrounded by several cells (Figs. 8 and 9). It lies close in the hypodermis and possesses a prominent external opening. These openings appear as triangular areas with a rather heavy chitinous Y-like centre surrounded by minute pores (Fig. 10). In longitudinal section the gland and its opening appears as in Fig. 8. These glands secrete the small, short, coiled wax threads found covering the entire body and mingled in the filaments. They are not present immediately surrounding the genital opening.

This type of gland is found in all the cerarii, closely investing the two spines (Fig. 18).

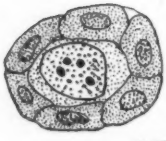


12

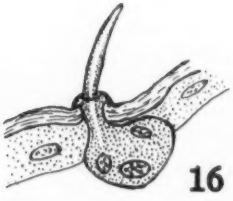
13



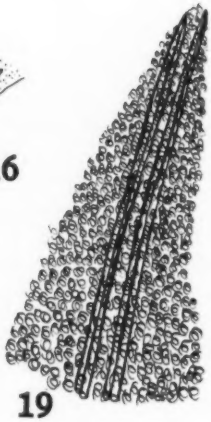
14



15

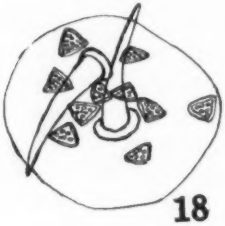


16



19

17



18

20

Robert Matheson

TYPE IV. This type is a very small gland always associated with a minute spine. It consists of three or four cells and lies almost as shallow as the hypodermis (Fig. 16). Studying the gland under high magnification there can be distinguished in most cases the prolongation of the cell cytoplasm directly to and into the spine itself. Within this narrow cylinder of cytoplasm can be seen plainly a minute duct which I believe opens at the tip of the spine. What the particular function of this type of gland may be or the kind of material secreted I have no means of determining. These glands are scattered over the body of the insect.

TYPE V. Scattered here and there may be found rather peculiar one and two celled glands (Fig. 17). I have been unable to determine the exact type of external opening of this gland and am still in doubt whether it is an actual gland or the beginning of one of the other glandular types. Visart (1896) states that he observed direct nuclear division in some of the glandular cells, but so far I have been unable to demonstrate such division.

WAX SECRETION.

Glands of Type II secrete the long straight threads that are found abundantly in the ovisac and a few, usually four, in the lateral filaments. Examination of the material in the ovisac shows it to be composed exclusively of two kinds—the long threads and a mass of short coiled threads attached to the long threads and about the eggs (Fig. 20). The short coiled threads are secreted by Type I and this type of gland is very abundant on the venter near the opening of the vagina. The long threads measure on the average from 2 to 2.5 microns in diameter, and this corresponds identically with the diameter of the neck of Type II gland.

The wax composing the lateral filaments is of interest. In each filament there appears two threads close to each other and these are surrounded by a mass of longer and shorter coiled threads (Fig. 19). On examination the two central threads are each found to be composed of two threads closely applied to each other. In diameter they measure 5 microns. Each set arises from two glands of Type II, situated close together near the cerarius. The threads issuing from these glands

become fused and thus form the supporting framework for the filament. Surrounding and between these threads is a very large mass of coiled wax threads. These coiled wax threads arise from Type I and the very short ones from Type III. Type III is found abundantly about each cerarius.

The general waxy covering of the body is composed of short coiled threads arising from glands of Type III. These glands are found very abundant all over the body of the insect.

LITERATURE CITED.

Berlese, A. Le cocciniglie Italiane viventi sulgi agrumi Parte I. Dactylopius. Avellino. 1893.

Sulc, K. Zur Anatomie der Cocciden. Zool. Anz. 34:164-172, 1909.

Visart, O. Contribuzione allo studio delle glandule ceripare delle cocciniglie (Dactylopius citri e Ceroplastes Rusci). Revis Patol. Vegst. 3:39-48. Tav. I. 1896.

do. Contribuzione all conoscenza delle glandule ceripare negli Afidi e nelle Cocciniglie. Boll. Soc. Natur. Napoli 8 122-126; Tav. 1895.

UNDESCRIBED SPECIES OF JAPANESE CRANE-FLIES
(Tipulidae, Diptera.)

Part III.

By CHARLES P. ALEXANDER.

The first two parts under this general title were published in these ANNALS in 1919 and 1921. Virtually all of the species included in the present report were sent to me for determination by Dr. Shiraki and were collected by himself and other entomologists, Messrs. Inamura, Isshiki, Issiki, Miyake, Okuni, Sonan and Yoshino. Additional material was sent by Dr. Machida. The writer's thanks are extended to all of these gentlemen for their co-operation in making known the large and very important Tipuloidean fauna of the Japanese Empire. Where not stated to the contrary, types of the novelties described herein are preserved in the collection of the writer.

Dicranomyia Stephens.

Dicranomyia (Idioglochina) kotoshoensis sp. n.

General coloration brownish yellow; head gray; mesonotal praescutum with three brown stripes; wings pale brown; *Sc* very short; *Rs* shorter than the deflection of R_{4+5}; veins R_1, R_{2+3} and R_{4+5} generally parallel to one another, straight.

Male—Length, about 5.5 mm.; wing, 5.6 mm.

Rostrum brown, the palpi dark brown. Antennæ dark brown; flagellum with the structure of the species of the subgenus, the verticils being very stout, almost spinous, arranged in a row around the periphery of the segment. Head gray.

Mesonotum yellowish pollinose with three broad, brown stripes, the median stripe becoming indistinct before the suture; scutal lobes brown, the median area paler; scutellum injured in pinning, apparently sparsely pruinose; postnotum brown, paler basally. Pleura brownish yellow with a sparse, microscopic gray pubescence. Halteres pale, the knobs slightly darker. Legs with the coxæ concolorous with the pleura; trochanters obscure yellow; femora obscure brownish yellow; tibiæ and tarsi brown; claws toothed. Wings pale brown; stigma barely indicated; veins brown. Venation: *Sc* short, Sc_1 ending far before the origin of *Rs*, this distance longer than the basal deflection of Cu_1, Sc_2 a short distance from the tip of Sc_1, the latter about equal to *m*; *Rs* very short, about two-thirds the deflection of R_{4+5}; R_{2+3} straight,

parallel to R_1; *r* very indistinct, at the tip of R_1; deflection of R_{4+5} arcuated, a little shorter than the basal deflection of Cu_1; outer section of R_{4+5} generally parallel with R_{2+3}; cell *1st* M_2 long, irregularly pentagonal, longer than any of the veins beyond it; basal deflection of Cu_1 just beyond the fork of *M*, about equal to Cu_2. Anal angle of wing conspicuous, as in subgenus.

Abdomen light brownish yellow, the basal tergites darker brown; hypopygium obscure yellow. Male hypopygium (described from the dry type only) with the pleurites comparatively long and slender, the proximal face at the base with a large, subglobular lobe that is provided with abundant, long, erect setæ; the two appendages are closely approximated, the outer hook stout, the inner fleshy appendage a little longer than the chitinized hook, terminating in a rather blunt, unarmed beak. Penis-guard conspicuous.

Habitat: Japan (Taiwan). Holotype, ♂, Island of Kotosho, March 15–April 10, 1920 (T. Okuni and J. Sonan). Type in the collection of the Agricultural Experiment Station, Taihoku.

Dicranomyia kotoshoensis is of unusual interest as being the first Oriental species of the subgenus *Idioglochina* Alexander to be described, the three species previously known being from the Australasian region (Waigeou to N. Queensland).

(?) **Dicranomyia shirakii** sp. n.

General coloration dark with a marmorate pattern of microscopic gray pubescence; legs yellow, the femoral tips, tibial bases and tips dark brown; wings whitish subhyaline with a heavy brown pattern, including five very extensive costal blotches; *Sc* ending opposite the origin of *Rs*, Sc_2 lacking; basal deflection of Cu_1 before the fork of *M*.

Male—Length, excluding head, 5 mm.; wing, 6.5 mm.

Head lacking.

Pronotum brown, marmorate laterally with gray pruinose. The thoracic pattern is more or less destroyed by verdigris and can be discussed in general terms only; mesonotal praescutum light gray pruinose with a broad, black, median stripe that is sparsely provided with golden yellow pollen; remainder of the mesonotum dark brown with a microscopic, appressed pubescence that appears as a sparse pruinosity. Pleura dark brown, handsomely marmorate with a silvery gray, microscopic pubescence; dorso-pleural membrane obscure yellow. Halteres white, the large knobs conspicuously dark brown. Legs with the coxæ brown, sparsely gray pubescent; trochanters obscure yellow; femora slender, bright yellow, the tips rather broadly and conspicuously dark brown; tibiæ brownish yellow, the bases and tips narrowly dark brown; tarsi dark brown. Wings whitish subhyaline with a heavy brown pattern; costal region with five very extensive brown blotches, the first at the level of the arculus, including both cells *C* and *Sc* and sending a cloud over arculus; second blotch near mid-distance between

arculus and the origin of *Rs*, sending a quadrangular cloud into cell *R;* third blotch above the end of *Sc* and origin of *Rs*, sending a rectangular cloud over the base of *Rs;* fourth blotch at stigma, sending a large cloud over the fork of *Rs*, separated from the fifth and apical blotch only by a large, rounded spot of the ground color in the base of cell *2nd* R_1; apical blotch includes more than the distal half of cell *2nd* R_1 and all of R_3 except a series of about six indistinct whitish spots; the white interspaces between the first three blotches do not equal more than one-fifth the blotch in extent; besides the above brown areas, the remainder of the cord and outer end of cell *1st* M_2 is broadly seamed with brown; paler brown clouds occupy most of cells *2nd* M_2, M_3, *Cu* and *M*, the base and outer ends of cells Cu_1, *1st A* and *2nd A*, there being large hyaline areas in the outer ends of cells *Cu*, *1st A* and *2nd A*, the brown clouds confined to the ends of the veins; veins dark brown, pale in the hyaline areas. Venation: Sc_1 ending opposite the origin of *Rs*, Sc_2 lacking; *Rs* gently arcuated, about twice the deflection of R_{4+5}; *r* at tip of R_1; deflection of R_{4+5} longer than the basal deflection of Cu_1; cell *1st* M_2 rectangular, almost as long as vein M_{1+2} beyond it; basal deflection of Cu_1 about one-half its length before the fork of *M;* vein *2nd A* gently bisinuous.

Abdomen brown, the hypopygium obscure yellow.

Habitat: Japan (Taiwan). Holotype, ♂, Tappan, altitude about 3,000 feet, June 18, 1917 (T. Shiraki). Type in the collection of the Agricultural Experiment Station, Taihoku.

?Dicranomyia shirakii is a very conspicuous crane-fly whose true generic position is rendered somewhat doubtful by the loss of the head of the type. It is almost certainly a *Dicranomyia*, but there is a possibility of its being a *Geranomyia* or a *Rhipidia*. It is named in honor of the collector, Dr. T. Shiraki, to whom I am indebted for many favors.

Dicranomyia subumbrata sp. n.

General coloration obscure yellow; head gray; pleura with a broad, dark brown stripe; wings tinged with brown; stigma, a spot at origin of *Rs* and conspicuous seams along the cord and outer end of cell *1st* M_2 seamed with brown; *Sc* long, cell *1st* M_2 closed; abdominal segments brown, paler basally; male hypopygium large and complex.

Male—Length about 5.5 mm.; wing, 6.2 mm.

Female—Length about 6 mm.; wing, 6.3 mm.

Rostrum and palpi dark brown. Antennæ dark brown, the flagellar segments oval-cylindrical. Head gray.

Mesonotal praescutum obscure yellow, the posterior median area broadly dark brown; lateral stripes obliterated; scutal lobes dark brown, the median area yellowish; remainder of the mesonotum brown. Pleura obscure yellow with a conspicuous, dark brown stripe extending from the cervical sclerites, beneath the halteres, to the abdomen. Halteres

brown, the base of the stem obscure yellow. Legs with the coxæ and trochanters obscure yellow; remainder of the legs dark brown, the femoral bases paler. Wings tinged with brown; stigma conspicuous, dark brown, circular in outline; a large paler brown spot at origin of *Rs*; seams along the cord, outer end of cell *1st* M_2 and at the tip of Sc_1, brown; veins dark brown. Venation: Sc_1 ending just beyond mid-length of *Rs*, Sc_2 at its tip; *Rs* slightly angulated at origin; *r* at tip of R_1 and at about one-third the length of R_{2+3}; cell *1st* M_2 closed, the basal deflection of Cu_1 at the fork of *M*.

Abdomen dark brown, the tergites narrowly pale basally; sternites yellow, ringed caudally with brown. Male hypopygium large and complicated in structure; pleurites short and stout, the meso-caudal angle produced mesad into a long arm, the margin of which is provided with a ledge set with microscopic spinulæ; pleural appendages much smaller than the pleurite, consisting of an outer chitinized hook and two inner, fleshy, curved lobes, the more proximal being bent at a strong angle. Penis-guard large; gonapophyses broad-based, the acute, slender tips directed strongly laterad, before the tip with close parallel ridges. Ovipositor with the tergal valves slender, strongly curved.

Habitat: Japan (Taiwan). Holotype, ♂, Horisha, December 20, 1916 (T. Shiraki). Allotopotype, ♀. Type in the collection of the Agricultural Experiment Station, Taihoku.

Dicranomyia subumbrata is related to the smaller *D. umbrata* de Meijere (Java), differing in the coloration of the abdomen, the hypopygial structure, and other characters.

Limonia Meigen.

Limonia nigronitida sp. n.

Head and thorax shiny black, the thoracic pleura with a microscopic, appressed, gray pubescence; halteres yellow; legs black, fore and hind femora with a narrow, yellow, subterminal ring; wings light yellow, spotted and clouded with brown; stigma large, oval, dark brown; *r* near the tip of R_1; basal deflection of Cu_1 before the fork of *M;* abdomen orange on basal half, black on the terminal half.

Male—Length, 11.5 mm.; wing, 12.5 mm.

Rostrum and palpi dark brownish black. Antennæ with the scape black, the flagellum dark brown throughout. Head shiny brownish black, the anterior part of the vertex and a narrow margin along the eyes with an appressed gray pubescence.

Pronotum elongate, black, the scutellum shiny dark brown. Mesonotum shiny black, the median area of the scutum and the scutellum very sparsely gray pubescent. Pleura black with a heavy appressed gray pubescence. Halteres pale yellow. Legs with the fore and middle coxæ dark brown, the posterior coxæ more shiny reddish, brown posteriorly; trochanters obscure yellow; femora black, rather narrowly

obscure yellow basally, before the black tip with a narrow yellow ring, this subobsolete on the mid-femora; remainder of the legs black. Wings light yellow, the base and cells *C* and *Sc* brighter yellow; stigma large, oval, dark brown; conspicuous rounded brown spots at origin of *Rs* and the deflection of R_{4+5}; an extensive paler brown wash at the wing-apex, occupying the outer ends of cells *2nd* R_1, R_3, the middle portion of R_5, *2nd* M_2 and M_3, the outer ends of these latter being pale; large, triangular pale brown clouds at ends of veins Cu_2 and *1st A;* cord and outer end of cell *1st* M_2 narrowly seamed with dark brown; a pale brown seam along the margin of cell *2nd A;* veins dark brown, paler in the flavous areas. Venation: Sc_1 ending beyond the fork of *Rs*, Sc_1 about twice *Sc2; Rs* angulated at origin; *r* about one and one-half its length from the tip of R_1; inner ends of cells R_3 and *1st* M_2 lying far proximad of cell R_5; basal deflection of Cu_1 before the fork of *M*.

Abdomen with the basal four segments obscure, light orange, unmarked, the remainder of the abdomen, including the hypopygium, shiny black, only the penis-guard and pleural appendages of the hypopygium a little paler.

Habitat: Japan (Hokkaido). Holotype, ♂, Teshio, July 4, 1916 (T. Isshiki). Type in the collection of the Agricultural Experiment Station, Taihoku.

Limonia nigronitida is not closely related to any of the four described European species with shiny black head and thorax (*pannonica* Kowarz, *nitida* Verrall, *splendens* Kuntze and *proxima* Kuntze). No American species of this group have been discovered.

Rhipidia Meigen.

Rhipidia (Rhipidia) rostrifera formosana subsp. n.

Male—Length about 5 mm.; wing, 5.5 mm.

Generally similar to *R.* (*R.*) *rostrifera* Edwards of the Malay Peninsula and Sumatra, differing as follows:

Mesonotal praescutum yellowish gray with three conspicuous dark brown stripes; median stripe broad, indistinctly split longitudinally by a pale line; lateral stripes conspicuous; scutal lobes with the centers dark brown; scutellum gray pruinose. Pleura gray with a narrow, longitudinal brown stripe ending beneath the root of the halteres. Mesosternum dark brown, the dorsal margin sharply delimited. Femora brown with a conspicuous, broad, darker brown, subterminal ring, the extreme tip narrowly pale. Wings with the brown pattern extensive, the outer costal blotch including the distal fourth of cell *2nd* R_1 and the distal two-fifths of cell R_3; stigmal blotch quadrate, confluent with the oval costal blotch at tip of *Sc*. Venation: Sc_2 lacking, the subcostal cross-vein present and surrounded by a small brown cloud; *Rs* elongate, strongly arcuated at origin; cell M_3 comparatively small, about one-half

the length of its petiole; basal deflection of Cu_1 beyond the fork of M, the distance a little shorter than r–m, Cu_2 being shorter than the deflection of Cu_1.

Habitat: Japan (Taiwan). Holotype, ♂, Funkiko, altitude about 6,000 feet, April 29, 1917 (T. Shiraki). Type in the collection of the Agricultural Experiment Station, Taihoku.

Gonomyia Meigen.

Gonomyia (Progonomyia) scutellum-album sp. n.

General coloration black; pronotal and mesonotal scutella whitish yellow; pleura dark brown, the epimeron yellow; knobs of the halteres light yellow; wings faintly tinged; Sc_1 ending about opposite two-thirds *Rs;* penis-guard very large and flattened near mid-length, the apex suddenly narrowed, acicular.

Male—Length about 4.5 mm.; wing, 6.6 mm.

Female—Length about 4 mm.; wing, 6.3 mm.

Rostrum and palpi dark brown. Antennæ dark brown, the segments oval. Head black, rather sparsely dusted with light gray.

Pronotum dark brown, the scutellum conspicuously light yellow. Mesonotum black, the scutellum conspicuously and abruptly whitish yellow. Pleura dark brown, the epimeron yellow. Halteres brown, the knobs conspicuously light yellow. Legs with the coxæ and trochanters dark brown; remainder of the legs dark brownish black. Wings with a faint brownish tinge, the stigma barely indicated; veins dark brown. Venation: Sc_1 ending about opposite two-thirds the length of *Rs*, Sc_2 far from the tip of Sc_1, closer to origin of *Rs* than to tip of Sc_1; *Rs* long, straight; *r* lacking; petiole of cell *2nd* M_2 about one-half longer than the basal deflection of Cu_1, the latter about one-third its length beyond the fork of M.

Abdominal tergites brown, the caudal margins of the segments rather broadly dark brown. Hypopygium paler brown, more nearly concolorous with the sternites. Male hypopygium with the lateral angle of pleurite a little produced; three pleural appendages; outer appendage pale, gradually narrowed apically; middle appendage cylindrical at base, near mid-length dilated into a collar, the lateral margin jutting out into a black lobe, the apical two-fifths very slender, gently curved; inner pleural appendage the shortest, the proximal face with long setæ. Penis-guard very large and highly compressed, slender basally, dilated into a roughly oval blade from the end of which the long, slender, needle-like extension of the guard continues, bent strongly near its origin and lying nearly parallel with the margin of the dilation.

Habitat: Japan (Taiwan). Holotype, ♂, Funkiko, altitude about 6,000 feet, April 21, 1917 (T. Shiraki). Allotopotype, ♀. Type in the collection of the Agricultural Experiment Station, Taihoku.

Gonomyia scutellum-album is related to *G. strenua* (Brunetti). It would seem better to refer both species to the subgenus *Progonomyia* of *Gonomyia* Meigen, although they differ somewhat from the characteristic form of the group.

Teucholabis Osten Sacken.

Teucholabis aberrans sp. n.

Head dark gray; mesothorax shiny reddish; wings tinged with brown, more saturated along costa; cell *2nd* M_2 with a short petiole; abdomen brownish black.

Male—Length, 7 mm.; wing, 6.5 mm.

Rostrum nearly as long as the remainder of the head, shiny black; palpi dark brownish black. Antennæ dark brownish black throughout. Head dark gray.

Pronotum reddish. Mesothorax entirely shiny reddish. Halteres dark brown. Legs with the fore and middle coxæ obscure reddish, the hind coxæ dark brown; trochanters dark brown; remainder of the legs broken. Wings strongly tinged with brown, darkest along the costal margin to the end of vein R_{2+3}; veins dark brown. Venation: Sc_1 ending about opposite three-fourths the length of *Rs*, Sc_2 at about three-fifths the distance between the origin of *Rs* and the tip of Sc_1; *Rs* long, nearly straight; *r* on R_{2+3} about its own length beyond the fork; cell *1st* M_2 elongate, the sides parallel; cell *2nd* M_2 with a short petiole that is a little longer than *r–m;* basal deflection of Cu_1 a little less than its own length beyond the fork of *M*.

Abdomen shiny brownish black, only the incisures of the terminal segments narrowly silvery.

Habitat: Japan (Taiwan). Holotype, ♂, Island of Kotosho, March 15–April 10, 1920 (T. Okuni and J. Sonan).

Teucholabis aberrans differs from all other described species by the petiolate cell *2nd* M_2. In its general appearance it suggests *T. inornata* Riedel.

Elephantomyia Osten Sacken.

Elephantomyia (Elephantomyodes) major sp. n.

General coloration light yellowish brown, the thoracic pleura brighter; legs black, the terminal tarsal segments snowy white; wings tinged with brown; cells *Sc*, Sc_1 and the outer end of R_1 dark brown; abdominal segments indistinctly bicolorous.

Male—Length (excluding rostrum), 11.5 mm.; wing, 10.4 mm.

Rostrum slender, black, if bent backward extending to about midlength of the abdomen. Antennæ with 14 segments, the basal segment greenish testaceous, the remainder black with elongate flagellar verticils. Front surrounding the insertion of the rostrum with a greenish yellow

tinge. Head brown, narrowed posteriorly; vertex between the eyes about as wide as the first scapal segment.

Mesonotum light yellowish brown without markings, the scutellum slightly more testaceous; postnotum narrowly and indistinctly darker brown medially. Pleura obscure yellow, the propleura darker; mesosternum more pruinescent laterally. Halteres pale, the knobs brown. Legs with the coxæ obscure yellow, the fore coxæ darker; trochanters obscure yellow; femora black, the bases narrowly paler; tibiæ black; metatarsi black, the narrow distal end and the remaining tarsal segments except the last, snowy-white. Wings with a brownish tinge; cells *Sc*, Sc_1 and the narrow outer end of R_1 dark brown; veins dark brown. Venation: *Rs* strongly arcuated at origin; veins Cu_2 and *1st A* widely separated at wing margin, the distance much longer than the basal deflection of Cu_1; vein *2nd A* comparatively short.

Abdomen dark brown, segments three to five with the basal half pale brown; segment six similar but the basal half even brighter, yellowish brown; remainder of abdomen dark brown, the small hypopygium a little brighter.

Habitat: Japan (Taiwan). Holotype, ♂, Island of Kotosho, March 15–April 10, 1920 (T. Okuni and J. Sonan). Type in the collection of the Agricultural Experiment Station, Taihoku.

Elephantomyia major is related to *E. fuscomarginata* Enderlein (Sumatra), from which it is distinguished by its larger size, coloration, and the details of venation, especially the wide separation of veins Cu_2 and *1st A* at the wing-margin. This section of the genus now includes seven species in the East Indies and North Australia, differing from *Elephantomyia* s. s. by the lack of tibial spurs and the details of venation, *Rs* being in alignment with the deflection of R_{4+5}, and R_{2+3} arising almost perpendicularly from the end of the sector. This group of Elephantomyiæ with spurless tibiæ should receive subgeneric rank and the name *Elephantomyodes* may be used, *E. major* being the type of this section.

Epiphragma Osten Sacken.

Epiphragma divisa sp. n.

Allied to *E. vicina* Brunetti; legs uniformly light yellow; wing-pattern very restricted, the band along the outer end of cell *1st* M_2 isolated from the basal pattern.

Male—Length about 8 mm.; wing, 8.2 mm.

Female—Length, 11 mm.; wing, 10.5 mm.

Rostrum pale, golden-yellow pubescent; palpi dark brown. Antennæ with the scapal segments dark brown, the long first flagellar segment light yellow; second segment yellowish brown; remaining flagellar

segments uniformly brown. Head brown, obscure yellow adjoining the inner margin of the eyes; vertex with a low tubercle.

Pronotum dark brown. Mesonotal praescutum rich fulvous, passing into dark brown behind; remainder of mesonotum dark brown, the base of the scutellum gray pruinose. In the female, the mesonotum is provided with a light gray bloom that almost conceals the fulvous ground color. Pleura dark with patches of pruinescence and yellow pollen, the more dorsal sclerites grayish; ventral and posterior sclerites with a sparse yellow pollen. Halteres pale brown, the apices of the knobs light yellow. Legs with the coxæ obscure yellow, the outer face of each slightly infuscated; remainder of the legs light yellow, the femora immaculate. Wings comparatively narrow, much narrower than in *E. insignis* Wulp or *E. subinsignis* Alexander; subhyaline with a restricted brown pattern arranged somewhat as in *E. vicina* Brunetti, but even more broken, the pale areas more extensive; the large brown oblique band that crosses the outer end of cell *1st* M_2 is quite compact and isolated from the other markings, more or less Y-shaped, one arm of the Y reaching the margin at R_2, the other, broader, at R_{4+5} and M_1. Venation: *Rs* strongly angulated at origin; R_{2+3} comparatively short, about one-half longer than the deflection of R_{4+5}; cell *1st* M_2 large, in the female with *m* long and sinuous; petiole of cell M_1 only about one-half the cell, in the female longer than in the male; basal deflection of Cu_1 before one-fourth the length of the cell.

Abdominal tergites light brown, the margins of the segments darker brown; hypopygium dark brown.

Habitat: Japan (Taiwan). Holotype, ♂, Shinchiku, altitude 500–1,000 feet, July 1–30, 1918 (J. Sonan and K. Miyake). Allotype, ♀, Musha, altitude about 3,700 feet, May 18–June 15, 1919 (J. Sonan, K. Miyake and M. Yoshino). Types in the collection of the Agricultural Experiment Station, Taihoku.

Limnophila Macquart.

Limnophila (Lasiomastix) macrotrichiata sp. n.

Generally similar to *L. flavella* Alex.; size larger; head light gray; no dark spot at wing-root; wings pale yellow, the stigma conspicuous, oval, pale brown; macrotrichiæ of wing veins and membrane very long and conspicuous; cell *1st* M_2 rectangular.

Male—Length about 6.8 mm.; wing, 8 mm.

Rostrum obscure yellow; palpi brown. Antennæ short, the first scapal segment elongate; scape and basal three flagellar segments obscure yellow, the remainder of the flagellum dark brown. Head light gray with proclinate yellow bristles.

Pronotum dark medially, pale laterally. Mesonotal praescutum shiny, obscure brownish yellow without markings; scutellum and postnotum a little clearer yellow. Pleura pale brown with a sparse, microscopic, gray pubescence to produce the effect of a pruinosity.

Halteres pale, the knobs a little darker. Legs with the coxæ light brown, gray pubescent like the pleura; trochanters yellow; remainder of the legs obscure yellow, the tibial tips a little darkened; tips of the metatarsi and remaining tarsal segments pale brown. Wings with no black spot at base; pale yellow with a conspicuous, oval, pale brown stigma; cord faintly seamed with brown; macrotrichiæ of both veins and membrane very large, distinctly larger than in the other described Japanese species of the subgenus, conspicuous even with a hand-lens; these trichiæ occupy all but the bases of cells *2nd* R_1, R_2, R_3, R_5, M_1 and *2nd* M_2 and because of their size appear to almost fill the cells; outer ends of cells Sc_1, M_2 and Cu_1 likewise provided with these long setæ. Venation: Similar to *L. flavella saitamæ* Alex., differing as follows: *Rs* longer and less arcuated at origin; *r* closer to tip of R_1 than to origin of R_2; cell M_1 about twice its petiole; cell *1st* M_2 rectangular, the basal deflection of Cu_1 near one-third its length; vein *2nd A* longer, gently sinuous near outer end.

Abdomen brown. Male hypopygium as in *L. f. saitamæ*, differing in the details of structure; what seems to be the ninth tergite has a very deep U-shaped notch with the lateral lobes much broader than the notch, their tips very obtusely rounded; inner pleural appendage with the inner arm more than one-half the length of the clavate outer arm and more appressed to it.

Habitat: Japan (Hokkaido). Holotype, ♂, Teshio, July 3, 1916 (T. Isshiki). Type in the collection of the Agricultural Experiment Station, Taihoku.

Limnophila (Dicranophragma) taiwanensis sp. n.

Male—Length, 5.5 mm.; wing, 6.4 mm.

Most closely related to *L.* (*D.*) *multipunctipennis* Brunetti (N. India), differing as follows:

Size smaller. Antennæ with the first segment dark brown, the subglobular second segment light brown; first flagellar segment conspicuously yellow; remainder of the flagellum dark brown. No dark median line on head. Mesonotal praescutum obscure yellow pollinose, the space between the median and lateral stripes capillary, brown; a circular brown spot occupying the lateral margin of the praescutum caudad of the pseudosutural foveæ. Wings with the five large costal areas relatively small and insignificant; basal blotch occupies only cells *C* and *Sc;* stigma oval, the extension of it along the cord much paler and more or less interrupted; wing-tip not uniformly darkened; a brown seam at the strongly curved tip of vein *2nd A;* the numerous dots in the cells are not at all dash-like, but subcircular in outline. Venation: Cell *1st* M_2 larger, longer than broad, with the basal deflection of Cu_1 at three-fifths its length; petiole of cell M_1 longer than the cell. Abdomen dark brown, the bases of the elongate pleurites of the male hypopygium obscure yellow.

Habitat: Japan (Taiwan). Holotype, ♂, Taito, altitude about 500 feet, February 25–March 27, 1919 (S. Inamura, J. Sonan and M. Yoshino). Type in the collection of the Agricultural Experiment Station, Taihoku.

Limnophila taiwanensis is very distinct from the two insular species, *L.* (*D.*) *remota* (Meijere) of Java, and *L.* (*D.*) *formosa* Alexander, of Formosa.

Eriocera Macquart.

Eriocera geminata sp. n.

Related to *E. hilpa* (Walker); mesonotal praescutum velvety black with three shiny blue-black stripes; femora yellow, the tips narrowly dark brown; wings dark brown with a yellow blotch before and another beyond the origin of *Rs* in cell *R;* a white oval blotch before the cord in cells *R* and *M;* abdominal tergites velvety black, the bases broadly glabrous with pearly blue reflexions.

Male—Length about 11.5 mm.; wing, 9.5 mm.

Rostrum and palpi black. Antennæ black, setaceous, if bent backward, extending about to the base of the abdomen. Head black; vertical tubercle inconspicuous.

Mesonotum opaque, velvety black, the praescutum with three shiny, blue-black stripes; centers of the scutal lobes shiny. Pleura black. Halteres black. Legs with the coxæ and trochanters black; femora yellow, the tips narrowly dark brown; tibiæ and tarsi dark brown. Wings dark brown; cells *C* and *Sc* paler. Anal cells paler grayish brown, broadly suffused along vein *2nd A;* two conspicuous elongate, yellow blotches in cell *R*, one before and one beyond the origin of *Rs;* a conspicuous, white, oval blotch before the cord, lying just before the outer ends of cells *R* and *M*, barely extending across the sector into cell *1st* R_1; veins dark brown. Venation: *r* on R_2 about its length beyond the fork of R_{2+3}; R_{2+3} a little longer than the deflection of R_{4+5}; cell M_1 lacking; basal deflection of Cu_1 just beyond midlength of cell *1st* M_2.

Abdominal tergites glabrous basally, with pearly bluish reflexions; caudal margins broadly velvety black, this margin on the intermediate segments occupying about the distal third of the segment; sternites velvety black, only the bases narrowly glabrous. Hypopygium black.

Habitat: Japan (Honshiu). Holotype, ♂, Island of Oshima, Tokyo-Fu, July 16, 1918 (T. Shiraki); Collector's No. 6979. Type in the collection of the author; additional specimens in the collection of Dr. Shiraki.

Eriocera fulvibasis sp. n.

General coloration black; antennæ short; mesonotal praescutum light gray with three dark brown stripes, the median stripe broadly split by a plumbeous line; femora fulvous yellow, the tips broadly

blackened; wings yellow, the stigma dark brown; veins broadly seamed with paler brown; abdomen black, the lateral margins of the intermediate tergites rather narrowly buffy fulvous.

Male—Length, 17 mm.; wing, 15.4 mm.

Rostrum and palpi black. Antennæ short, ending a little before the wing-root, brownish black. Head brownish black.

Mesonotal praescutum light gray with three dark brown stripes, the median stripe broadly split by a plumbeous line that ends before the suture; lateral stripes crossing the suture and occupying the centers of the scutal lobes; scutellum sparsely pruinose, the margin fringed with setæ; postnotum black, glabrous. Pleura black, sparsely gray pruinose. Halteres short, brown, the knobs dark brown. Legs with the coxæ and trochanters black, sparsely gray pruinose; femora fulvous yellow, the tips broadly blackened, this occupying approximately the distal fifth; remainder of the legs brownish black. Wings yellow, the stigma dark brown; cells *C* and *Sc* more saturated; cord, outer end of cell *1st* M_2, veins *R*, *Rs*, *Cu* and *2nd A* broadly suffused with brown; veins beyond the cord and the wing-apex more narrowly seamed with brown; veins dark brown. Venation: Sc_1 ending beyond the fork of R_{2+3}, Sc_2 almost exactly opposite this fork; *Rs* about one-half longer than *R*; R_{2+3} shorter than the deflection of R_{4+5}; *r* a little before midlength of R_2 and about twice its length from the tip of R_1; cell M_1 lacking; cell *1st* M_2 rectangular, shorter than vein M_{1+2} beyond it, but slightly longer than M_3; basal deflection of Cu_1 at about one-third the length of the cell.

Abdomen black, the lateral margins of tergites two to five rather narrowly but conspicuously buffy fulvous; abdomen rather densely pubescent; sternites brownish black, sparsely gray pubescent; a narrow median, fulvous line on sternites two and three; hypopygium black. Pleurites elongate, conspicuous, much longer than the slender pleural appendages.

Habitat: Japan (Hokkaido). Holotype, ♂, Teshio, July 12, 1916 (T. Isshiki). Type in the collection of the Agricultural Experiment Station, Taihoku.

Eriocera fulvibasis bears a general resemblance to *E. longifurca* Alexander (Honshiu), differing in the coloration of the body and legs.

Rhaphidolabis Osten Sacken.

Rhaphidolabis consors sp. n.

Antennæ with twelve segments; general coloration buffy, the mesonotal praescutum with two broad, submedian brown stripes that are confluent or nearly so; head gray; wings subhyaline, stigma barely indicated; abdomen dark brown.

Female—Length about 4.5 mm.; wing, 6.2 mm.

Rostrum and palpi brown. Antennæ brown, twelve-segmented, the terminal segment longer than the penultimate. Head gray.

Mesonotum pale buff, the praescutum with two broad, submedian brown stripes that are nearly confluent; postnotum sparsely pruinose. Pleura buffy, sparsely gray pruinose. Halteres pale, the knobs dark brown. Legs with the coxæ and trochanters pale; remainder of the legs brown. Wings subhyaline, the stigma barely indicated; veins pale brown. Venation: Sc_1 ending some distance beyond the fork of R_{2+3}; *Rs* gently arcuated; R_{2+3+4} about as long as the basal deflection of Cu_1; R_2 very faint, lying close to the tip of R_1; cell M_1 present; cell *1st* M_2 open; M_{3+4} before the basal deflection of Cu_1 a little shorter than the latter.

Abdomen dark brown; valves of the ovipositor horn-colored.

Habitat: Japan (Honshiu). Holotype, ♀, Tamagawa, Saitama-Ken, November 13, 1920 (H. Machida).

I am indebted to Dr. Machida for this distinct species of *Rhaphidolabis*.

Tricyphona Zetterstedt.

Tricyphona grandior sp. n.

Size large (wing, ♂, 18 mm.); head and thorax dull gray; wings brownish yellow, the cord seamed with brown; abdomen dark brown, the terminal segments still darker.

Male—Length, 18 mm.; wing, 18 mm.

Rostrum dull gray; palpi dark brown. Antennæ very small, the scape dark brown; basal segments of flagellum brownish yellow, the distal segments darkened; flagellar segments becoming greatly crowded and rapidly decreasing in size to the tip; only nine flagellar segments are present, the terminal segment apparently formed by the fusion of two small segments. Head dull gray; on vertex behind antennæ and between the eyes, a conspicuous black, circular depression.

Pronotum dark gray, the scutellum reddish brown. Mesonotal praescutum dull whitish gray with three clearer gray stripes; remainder of the mesonotum dark, light gray pruinose, the postnotum blackened posteriorly. Pleura dark, light gray pruinose; dorso-pleural membrane light brown. Halteres dull yellow, the tips of the knobs a little darkened. Legs with the coxæ obscure yellow, the bases indistinctly pruinose; trochanters dull yellow; legs comparatively stout and hairy; femora brownish yellow, the tips conspicuously dark brown; tibiæ brown, the tips darker brown; tarsi dark brown. Wings with a strong brownish yellow tinge, cells *C* and *Sc* more yellowish; central portion of the disk clearer; a brown tinge in cell *R* from arculus to beyond the origin of *Rs;* stigma and a conspicuous seam along the cord dark brown; *h* and Sc_2 narrowly seamed with brown; veins dark brown. Venation: Sc_2 ending opposite the origin of *Rs;* *Rs* angulated and spurred at origin; *r–m* connected with *Rs* about its length before the fork; R_{2+3} a little longer than R_3; R_2 about one-half or less R_1 plus R_2; R_{4+5} about equal to R_3, shorter than its branches; cell *1st* M_2 closed; *m* a little shorter than the petiole of cell M_1; basal deflection of Cu_1 at fork of *M;* fusion of M_3 and Cu_1 extensive, longer than the basal deflection of Cu_1 alone.

Abdomen with the first tergite obscure yellow basally, the posterior two-thirds darkened; tergites two to four obscure brownish yellow with a broad, ill-defined median stripe; remaining tergites dark, gray pruinose; sternites similar but segments two to four without median stripe. Male hypopygium with the pleural appendage a shiny, obtuse arm that is densely set with more than a score of blackened spines, directed mesad, the whole structure resembling a mace, the mesal end more pointed; ventral margin of this appendage armed with a dense brush or comb of spinous bristles.

Habitat: Japan (Honshiu). Holotype, ♂, Mt. Hakuba, Province of Shinano, July 20, 1918 (S. Issiki). Type in the collection of the Agricultural Experiment Station, Taihoku.

Nesopeza Alexander.

Nesopeza taiwania sp. n.

General coloration dark brown, the praescutal stripes paler than the ground-color; antennæ of male comparatively short; abdomen dark brown, the hypopygium paler.

Male—Length, 8.5 mm.; wing, 10 mm.

Generally similar to *N. orientalis* (Brunetti), differing as follows:

Antennæ of male much shorter, if bent backward not extending far beyond the base of the abdomen, provided with conspicuous verticillate setæ; in *orientalis* the male antennæ are long, extending at least to the base of the fourth abdominal segment and the antennal verticals are very small. Head shiny dark brown. Mesonotal praescutum dark brown with three paler brown stripes, the median stripe divided by a capillary darker line; scutal lobes dark brown, the median area pale. Mesepisternum shiny dark brown, the remaining pleurites paler. Halteres pale, the knobs dark brown. The legs are broken in the type, but Edwards describes them as having the white apices less extensive. Wings suffused with darker; stigma oval, dark brown; *Rs* less arcuated at origin; R_{2+3} longer than the basal deflection of Cu_1. Abdomen dark brown, the hypopygium brighter.

Habitat: Japan (Taiwan). Holotype, ♂, Ringaurin, Nanto, December 18, 1916 (T. Shiraki). Type in the collection of the Agricultural Experiment Station, Taihoku. An additional male in the collection of the British Museum (Natural History).

Edwards (Ann. Mag. Nat. Hist., ser. 9, vol. 8, p. 106; 1921) records this species from the type-locality. His material was badly damaged and was referred provisionally to *N. orientalis* (Brunetti). A comparison of the type of *N. taiwania* with metatypes of *N. orientalis* kindly sent me by Brunetti shows the two species to be distinct.

Pselliophora Osten Sacken.

Pselliophora vulcan sp. n.

General coloration obscure yellow and dark brown; mesonotal praescutum dark brownish black; posterior tibiæ with a broad white ring; wings dark brown with a conspicuous yellow band before cord; abdomen with the apex broadly blackened.

Male—Length, 16 mm.; wing, 12.8 mm.

Frontal prolongation of the head brown, narrowly yellowish dorsomedially; palpi pale brownish testaceous, the terminal segment dark brown. Antennæ with the scape obscure brownish yellow; flagellum dark brown, the branches brownish black. Head brown, more reddish brown posteriorly.

Pronotum brown, the scutellum obscure yellow. Mesonotal praescutum brownish black, only the lateral margins a little paler; a small, yellow, V-shaped mark immediately cephalad of the suture; remainder of mesonotum dark brown. Pleura dark brown, sparsely variegated with yellow; dorso-pleural membrane yellow; an elongate yellow mark on the lateral sclerites of postnotum and the caudal portion of mesepimeron. Sternites dark brown, the dorsal margin of the mesosternum between the mid- and hind-coxæ yellow. Halteres brown, the base of the stem narrowly yellow. Legs with the coxæ dark brown, the basal margin of the posterior coxæ pale; trochanters dark brown; femora brownish black, only the extreme bases paler; tibiæ black, posterior tibiæ with a broad, yellowish white ring beyond the base, this ring barely indicated on the mid-tibiæ; tarsi black. Wings dark brown; cells *Cu*, *1st A* and *2nd A* more brownish gray; a broad yellow crossband extending almost across the wing before the cord, including cells *C*, *1st* R_1 and the outer ends of cells *R* and *M;* a narrower extension follows along vein Cu_2 in cells Cu_1 and *Cu* to the wing-margin; the proximal half of the stigma lies in this yellow band and is much brighter colored; indistinct paler areas as follows: Cell *C* before *h;* the extreme bases of cells *R*, *M* and *Cu;* an indistinct pale crossband about midlength of cells *Cu* and *1st A;* wing axil conspicuously dark brown, faintly margined with yellow; an obliterative area before the cord, traversing cell *1st* M_2. Wing-petiole fringed with yellow hairs. Venation: Cell M_1 narrowly sessile; *m-cu* distinct.

Abdomen with the basal tergite brown; second tergite yellow on more than the basal half, the apex brown; tergites three to five obscure yellowish brown, the posterior margins darker; remaining tergites black; sternites one to six yellow, the posterior margins darkened; terminal sternites black. Male hypopygium large, black, the ninth segment long and cylindrical. Ninth tergite large with a very deep V-shaped notch, the lateral lobes terminating in subacute shiny points, the ventro-mesal sides of the lobes microscopically punctured. From the region of the ninth sternite there juts dorsad two conspicuous appendages, an inner, cylindrical dark lobe that is covered with a dense, short, golden pubescence and with long bristles on outer face. What is

presumably the gonapophyse appears as an acute, chitinized spine with the base broad, the proximal face with microscopic, longitudinal, parallel ridges, jutting dorsad from the notch of the ninth sternite, from the base of the notch sending ventrad two connate cylindrical arms. Eighth sternite not projecting.

Habitat: Japan (Honshiu). Holotype, ♂, Island of Oshima, Tokyo-Fu, July 16, 1918 (T. Shiraki). Type in the collection of the Agricultural Experiment Station, Taihoku.

Pselliophora vulcan is related to *P. fumiplena* (Walker) and *P. flavibasis* Edwards, but is very distinct from both.

Tipula Linnæus.

Tipula curvicauda sp. n.

General coloration gray; mesonotal praescutum shiny black, only sparsely pruinescent; wings brownish yellow, stigma oval, dark brown; abdomen yellow with two sublateral brown stripes, the terminal segments entirely brownish black; male hypopygium massive, subglobular; outer pleural appendage larger than the inner, appearing as a strongly curved, cylindrical arm.

Male—Length, 18 mm.; wing, 22 mm.

Frontal prolongation of the head grayish pruinose; palpi and mouthparts brown. Antennæ with the scapal segments light yellow, the flagellum broken. Head dark, heavily gray pruinose.

Pronotum gray, narrowly yellowish medially. Mesonotum black, the praescutum only thinly dusted with gray, especially laterally to leave four narrow blackish stripes; scutum and postnotum more heavily pruinose. Pleura light gray pruinose; dorso-pleural membrane light yellow. Halteres obscure brownish yellow. Legs with the coxæ light gray, the apices yellow; trochanters yellow; remainder of the legs broken. Wings with a strong brownish yellow tinge, the base and cells *C* and *Sc* brighter yellow, stigma oval, dark brown; an obliterative area before the stigma, extending from the end of cell *R* across the base of cell *1st* M_2 into M_4, narrowly interrupted by a brown cloud at *r–m* and the deflection of R_{4+5}; veins dark brown. Venation: *Rs* longer than R_{2+3}, but shorter than R_3; R_2 persistent; petiole of cell M_1 shorter than *m*; cell *1st* M_2 pentagonal; *m–cu* punctiform, at about one-third the length of cell *1st* M_2.

Abdomen with the basal tergite and proximal half of second tergite yellow; tergites two to five yellow with broad, dark brown, sublateral stripes that gradually obliterate the narrow, pale, median vitta; lateral margins of tergites two to seven broadly pale; caudal margins of tergites five and six more narrowly pale; eighth and ninth segments brownish black. Basal sternites yellow, the terminal segments dark brown. Hypopygium large and conspicuous, subglobular, tilted at an angle to the remainder of the abdomen. Ninth tergite massive, the caudal margin with a very broad U-shaped notch. Outer pleural appendage

very remarkable, a long, powerful arm that is strongly curved before midlength. Eighth sternite unarmed.

Habitat: Japan (Honshiu). Holotype, ♂, Kamikohti, Province of Shinano, July 13, 1918 (S. Issiki). Type in the collection of the Agricultural Experiment Station, Taihoku.

Tipula microcellula sp. n.

General coloration yellowish brown, sparsely pruinose; antennæ of male elongate; wings subhyaline, stigma brown; cell *1st* M_2 very small, pentagonal; abdomen black, only the basal tergites paler sublaterally.

Male—Length about 9 mm.; wing, 10.5 mm.

Frontal prolongation of the head obscure brownish yellow, darker above; nasus long and slender; palpi yellowish brown, the terminal segments dark brown. Antennæ elongate, if bent backward extending about to the base of the third abdominal segment; scape and base of first flagellar segment obscure yellow; remainder of antenna dark brown, the basal enlargements a little darker. Head obscure yellowish brown, darker posteriorly; a capillary, median, brown vitta.

Mesonotal praescutum yellowish gray with three very indistinct brighter brown stripes, the median stripe split by a capillary gray vitta; remainder of the mesonotum reddish brown, dark gray pruinose. Pleura reddish brown, the mesepimeron more testaceous, the pleura sparsely pruinose. Halteres dark brown, the extreme base of the stem yellow. Legs with the coxæ obscure yellow, narrowly darkened basally; trochanters obscure yellow; femora obscure brownish yellow, the tips darkened; tibiæ similar, the tips narrowly darkened; tarsi black, the base of the metatarsi paler. Wings subhyaline; stigma conspicuous, brown; veins brownish black, very narrowly and indistinctly margined with darker; an obliterative area before the stigma, crossing cell *1st* M_2. Venation: Sc_2 ending about opposite five-sixths the length of the long sector; R_{2+3} a little more than one-half *Rs;* R_2 straight, both sections in alignment, the basal section only a little shorter than the terminal section; R_{2+3} and R_3 in alignment; cell *1st* M_2 very small, pentagonal, the first and second sections of M_{1+2} long, the second section of M_{3+4} still longer; *m* and the first section of M_{3+4} short; cells M_1, *2nd* M_2 and M_4 very deep; *m–cu* punctiform; cell *2nd A* moderately wide.

Abdomen brownish black, the five basal tergites with a faintly indicated paler sublateral stripe; hypopygium black. Male hypopygium small. Ninth tergite entirely separate from the sternite, the pleurite incompletely cut off from the sternite by a long dorsal and a shorter ventral suture. Ninth tergite black with a very deep U-shaped notch, the base of which is occupied by a slightly lower, shiny shelf; lateral lobes rather narrow, the tips obtuse. Ninth pleurite triangular, the apex produced caudad into a conical lobe; outer pleural appendage cylindrical with elongate bristles. Ninth sternite with a very deep, parallel-sided incision. Eighth sternite unarmed.

Habitat: Japan (Taiwan). Holotype, ♂, Funkiko, altitude about 6,000 feet, April 25, 1917 (T. Shiraki). Type in the collection of the Agricultural Experiment Station, Taihoku.

In its venation, *T. microcellula* resembles the African *T. dolichopezoides* Alexander.

Tipula edwardsella nom. n.

New name for *Tipula flavicosta* Edwards, Ann. Mag. Nat. Hist., ser. 9, vol. 8, pp. 106, 107; 1921; preoccupied by *T. flavicosta* Alexander, Proc. U. S. Nat. Mus., vol. 49, pp. 187, 188; 1915.

Mr. Edwards has suggested that I rename his species which was found to be preoccupied. It is with pleasure that this handsome crane-fly is dedicated to Mr. Edwards in appreciation of his critical studies on the Tipulidæ of Taiwan.

Tipula edwardsella belongs to the *mutila* group, a Palæarctic aggregation that is now known to include the following species: *T. mutila* Wahlgren (N. Europe), *T. flavocostalis* Alexander (Japan, Honshiu to Karafuto), *T. percara* Alexander (China, Kwei-chow) and the present species, which is only known from the highest mountains of Taiwan (altitude 10,000 feet).

Tipulodina Enderlein.

Tipulodina nipponica sp. n.

General coloration brownish plumbeous; femora without a pale subterminal ring; fore tibia with one white ring, posterior tibia with two white rings; metatarsi with more than basal half black; wings yellowish subhyaline with a heavy brown pattern.

Female—Length to base of ovipositor, 25 mm.; wing, 19.5 mm.

Frontal prolongation of the head light gray; nasus and palpi brownish black. Antennæ with first scapal segment light yellow, the tip faintly darkened; second segment brownish yellow; flagellum black. Head silvery gray in front, passing into dull gray on the vertex.

Mesonotal praescutum light brownish gray with three very broad, dark brownish plumbeous stripes, the broad median stripe divided by a capillary, dark brown line; remainder of mesonotum dark brownish plumbeous. Pleura light silvery gray, the dorso-pleural membrane light yellow. Halteres brown. Legs with the coxæ light gray pruinose; trochanters yellow; femora obscure yellow, the tips broadly blackened, narrowest on fore legs, broadest on posterior legs; no pale subterminal ring on femora; tibiæ dark brown, fore tibia with a rather narrow (3.5 mm.) white ring before the subequal black tip; middle legs broken; posterior tibia with two white rings, a narrower ring (3 mm.)

immediately beyond the base, a broader (5 mm.) ring before the narrow (3 mm.) black tips, the intermediate black band being approximately equal in extent to the two white bands combined (8 mm.); metatarsi white with from three-fifths (fore legs) to more than half (hind legs) black; remainder of tarsi white, only the terminal segment a little darkened. Wings yellowish subhyaline, heavily marked with brown; cell *Sc* and the stigma dark brown; a brown seam along the cord, interrupted at the deflection of M_{1+2}; wing-tip in cells R_2, R_3, R_5 and the distal half of M_1 dark brown; a broad brown seam along outer end of vein *M*, basal deflection of M_{3+4}, the basal deflection of Cu_1 and Cu_2, almost filling cell Cu_1; a small, subhyaline droplet in the base of cell Cu_1 and another in the end of cell *M;* cell *Cu* and *1st A*, except the base, clouded with brown; veins issuing from cell *1st* M_2 seamed with brown; veins dark brown. Venation: *Rs* only a little shorter than R_{2+3}; petiole of cell M_1 shorter than *m;* cell *2nd A* very narrow.

Abdominal tergites dark brown, the caudal margins of the segments very narrowly, the lateral margins more broadly, buffy yellow; sternites more uniformly buffy yellow, the terminal segment darkened; ovipositor broken beyond base.

Habitat: Japan (Seikaido). Holotype, ♀, Yabakei, August 6, 1918 (T. Shiraki). Type in the collection of the Agricultural Experiment Station, Taihoku.

Tipulodina brunettiella sp. n.

The specimen determined by Brunetti as *Tipulodina pedata* (Rec. Ind. Mus., vol. 15, pt. 5, p. 272; 1918, description; Fauna Brit. India, Dipt. Nematocera, Pl. 5, fig. 4; 1912, figure) is obviously not this species and represents an undescribed form which is named as above. It is distinguished from all described species of the genus by the black costal cell. Brunetti further characterizes the fly as having only the fore femora with a moderately broad, pale apical ring and the basal half of the fore metatarsi and basal third of the hind metatarsi black. Brunetti has determined this species as being *pedata*, although it lacks the brown blotch near mid-length of cell *M*. Wiedemann's description is very clear on this point and I have no doubt but that the species earlier (Proc. U. S. Nat. Mus., vol. 49, pp. 183–185; 1915) determined as *pedata* by the writer really pertains to the species.

Tipulodina taiwanica sp. n.

Related to *T. magnicornis* Enderlein; posterior femora with a pale subterminal ring; posterior tibiæ with a single white ring, subterminal in position; male hypopygium with the pleural appendages not conspicuously projecting.

Male—Length about 28 mm.; wing, 22 mm.

Frontal prolongation of the head brown, narrowly darker dorsomedially; palpi dark brown. Antennæ much longer than in *T. pedata*, if bent backward extending nearly to the base of the halteres; first scapal segment obscure yellow; remainder of antenna black. Head with the front and anterior part of the vertex light yellow; remainder of the head brown, the median line narrowly darker, the inner margin of the eyes narrowly paler.

Mesonotal praescutum obscure brownish yellow with three brown stripes, the median stripe narrow, the lateral margins fading into a paler brown; lateral stripes broad but ill-defined; remainder of mesonotum brown with a darker capillary brown median line, the lateral margins paler. Pleura pale yellow, the lateral sclerites of the postnotum before the halteres with a brown margin. Halteres dark brown. Legs with the coxæ pale, the posterior coxæ with a large brown basal spot; trochanters yellow; legs broken except one posterior leg; in this the femora have a distinct pale subterminal ring followed by the subequal black apex; tibiæ with only the subterminal white ring, this subequal (3.7 mm.) to the black tips; tarsi broken beyond base. Wings subhyaline; cell *Sc* and the stigma dark brown; a tiny brown cloud at origin of *Rs* and a broad seam along the cord, interrupted on the basal deflection of M_{1+2}; Cu_2 and the deflection of Cu_1 conspicuously seamed with brown; a conspicuous brown seam in the outer end of cell R_2 and the distal half of R_3. Venation: Almost as *T. magnicornis* Enderlein (Sumatra); petiole of cell M_1 shorter than *m;* basal deflection of Cu_1 at about one-fourth the length of the cell.

Abdomen reddish brown, the bases of the tergites narrowly more yellowish. Male hypopygium very different in structure from *T. pedata* or *T. magnicornis;* shiny reddish, short-cylindrical, tilted at an angle to the remainder of the abdomen. Ninth tergite very broad and tumid, the caudal margin with a very shallow emargination that bears two widely separated knobs that are clothed with dense short bristles. Tergite and pleurite fused; pleural appendage not projecting beyond the genital chamber, a complex flattened blade with the posterior margin shiny and heavily blackened; ventral pleural suture long and straight. Ninth sternite tumid, with a profound and very narrow V-shaped median notch. Eighth sternite not conspicuously produced caudad.

Habitat: Japan (Taiwan). Holotype, ♂, Shinchiku, July 1–30, 1918 (J. Sonan and K. Miyake). Type in the collection of the Agricultural Experiment Station, Taihoku.

THE VALUE OF LANDMARKS IN INSECT MORPHOLOGY*

ALEX. D. MACGILLIVRAY,
University of Illinois.

The early students of human and comparative anatomy used a sort of hit and miss method in the identification of structures. Time was required for study and exploration to allow for sufficient advancement so that criteria could be established for determining homologies. With the steady advance of anatomical knowledge the identification and establishment of criteria, landmarks, became an important feature. A dictionary of medical terms like that of Gould defines landmarks as "superficial marks, such as eminences, lines, and depressions, that serve as guides to, or indications of deeper seated parts. The knowledge of landmarks is of the utmost importance, both to the surgeon and to the physician."

If external insect morphology is to become of value to the systematist and the homology of the various sclerites is to become fixed, the student of insect-anatomy must establish some method for the identification and location of such landmarks as will serve for the identification of sclerites. The use of landmarks makes for a continuous advancement, any other method makes for the accretion of facts without marked advancement.

Some of the more striking landmarks of the head-capsule that might be cited are the following: The epicranial suture, the precoila, the postcoila, the paracoila, the pretentorina, the metatentorina, the corpotentorium, and the odontoidea.

The inverted Y-shaped suture, the epicranial suture, the stem of the Y, the epicranial stem and each of the two sides an epicranial arm, is believed to mark the line of closure of the head-capsule during embryonic development. This suture is more frequently present in immature insects than in adults, but wherever present marks the position of the front and clypeus enclosed between the epicranial arms and the greater part of the

*Contributions from the Entomological Laboratories of the University of Illinois. No. 74.

head, the vertex, divided into two parts by the epicranial stem. The presence of this suture is indicative not only of the exact position of the sclerites named, but of a generalized condition of the head-structures.

The places where the mandibles and maxillæ are articulated are also important landmarks. The portion of the articular surface on the head or body is known as a coila, while the articular part of the appendage working against the coila is known as an artis. The cephalic articulation of each mandible, a precoila, is always located in the lateral angles of the clypeus, a slight projection on each side that is evidently homologous with the clypealiæ found in the clypeus of the larvæ of Corydalis. The presence of the precoilæ in the clypeus always makes a sure method of identifying this sclerite in all insects where the mandibles are distinct, no matter whether the precoiliæ occur on the cephalic or caudal, or on the dorsal or ventral aspects. The condylar swelling on the mandible articulating in the precoila is the preartis. The other coila of each mandible, the postcoila, is always located in the postgena and serves for the identification of this sclerite, since its limiting suture, the occipital suture, is generally wanting. The value of the postcoilæ in identifying the postgenæ is well shown in the Coleoptera where the postcoilæ are always distinct. The articulation of each maxilla, a paracoila, is also always located in a postgena. The condylar paracoilæ differ from the precoilæ and postcoilæ which are always acetabula. A similar condition is found in other coilæ, they may be either acetabula or condyles, which makes the use of these words, because of the variation in their form, impractical to use.

The point on the external surface where each anterior arm of the tentorium, a pretentorium, is invaginated, a pretentorina, can usually be identified as a depression, pit, or thickening. In generalized insects the pretentorinæ are always associated with the precoilæ and the ends of the epicranial arms and are of great value in fixing the identity of these structures. Where the epicranial stem and the precoilæ are wanting or cannot be identified as in most insects with sucking mouth-parts, the pretentorinæ serve as important landmarks in identifying the epicranial arms along which they may migrate until distant from the clypeus. This migration is so marked in many Diptera and

Hymenoptera that the pretentorinæ have been identified as the supratentorinæ. The relation of the pretentorinæ to the so-called fronto-genal sutures of the orthopterists is direct evidence that they are not distinct sutures, but only the modified ends of the epicranial arms. The presence of pretentorinæ in such moths as the sphingids offers conclusive evidence as to the true homology of the mandibles and pilifers.

The places where the antennæ are articulated to the head-capsule would seem to offer excellent landmarks for the identification of sclerites. The condition and arrangement of the sclerites on the cephalic and caudal aspects of the head, their relation to the occipital foramen, and the position of the occipital foramen show conclusively that such a condition as is found in the Orthoptera with the mouth directed ventrad is more primitive than such a condition as is found in the Plecoptera and Coleoptera, where the mouth is directed cephalad. It is possible to arrange a series of heads showing the development of the plecopterous and coleopterous type from the orthopterous type. The position of the mouth is directly correlated with the method of feeding and the type of mandibular development of the insect. The Coleoptera were undoubtedly derived from insects with the mouth directed ventrad or of the hypognathous type, but all the generalized existing species of Coleoptera have a prognathous type of head or one with the mouth directed cephalad. Several groups of beetles have a hypognathous type of head, but this is an acquired condition as is easily proven by a study of the position of the occipital foramen and the adjacent sclerites, in other words the head is simply bowed at middle. The use of the landmarks named and the metatentorina and gula prove this. In the Coleoptera with the prognathous type of head the antennæ are located in front of the compound eyes while in the hypognathous type of head the antennæ are articulated near together on the middle of the cephalic aspect. A series of heads will show all sorts of positions between those named. A similar migration can be shown in the insects of other orders, all of which goes to show that the articulations of the antennæ are apparently unstable in position and change their location with the change in the shape of the head and the direction of the mouth. The antennæ are usually articulated to the vertex,

but may be articulated to the front. They are not only not fixed in position, but are not definite in their migrations and are consequently not of value, except in very special cases, as landmarks in determining the identity of sclerites.

The corpotentorium, which is formed from a fusion of the metatentoria, is always of value in identifying the position of the postgenæ. It is also an important landmark for indicating the relation of the sclerites that surround the occipital foramen.

The neck or cervix usually contains sclerites on each side, the cervepisternum and cervepimeron, the former of which always articulates against the head. This point of articulation is generally a tooth-like projection on the walls of the head limiting each side of the occipital foramen. It projects into the foramen and each is known as an odontoidea, which serves not only as a landmark of the points of articulation between the head and thorax, but as marking the limits of the occiput and postgenæ. The occipital suture is usually obsolete and the portion of the head-capsule surrounding the occipital foramen dorsad of a line drawn through the odontoideæ is considered as the occiput and the portion ventrad as the postgenæ. Both the occiput and postgenæ are continuous with and indistinguishable from the vertex, of which the genæ, not a distinct sclerite, is a part. While the limits of the postgenæ are not definite, yet by the use of the odontoideæ, the postcoilæ, the paracoilæ, and the corpotentorium much can be determined as to their limits.

The metatentorinæ, structures rarely indicated or mentioned in morphological studies, are of primary importance in identifying structures of the caudal or ventral aspect of the head, depending upon whether it is of the prognathous or hypognathous type. They mark the places where the metatentoria are invaginated, are usually distinct pits, and are always located in the postgenæ near to the lateral ends of the corpotentorium, but always on the outside of the body. They are consequently located near the occipital foramen and the paracoilæ. The metatentorinæ are of primary importance as landmarks in maping out the gula, a structure that is found only in the order Coleoptera, where it can be seen in its primitive condition, in the order Neuroptera where it reaches its maximum development and is prominent in both larvæ and

adults, and in the order Trichoptera where its reduction and specialization in many species is striking. All sorts of head structures have been described as a gula, as a part of the submentum, a part of the ligula, a part of the postgenæ where they have migrated mesad below the occipital foramen and fused, and other structures. The use of metatentorinæ as landmarks for marking off the gula shows conclusively that a gula is present only in the orders named and that the modification of neck structures has had absolutely nothing to do with its origin. The Mecoptera, which are generally placed next to the Neuroptera, do not have a gula and should be associated instead with the Hymenoptera with which they are related. The three orders with a gula are a homogenous group and it should be easy to decide whether the Micropterygidæ belong with the Trichoptera or not by the presence or absence of a gula. If a gula is present the conformation of the head will be very different from those species of Lepidoptera lacking it. The frenate Lepidoptera and the Hepialidæ do not have a gula, although a bar of the labium has been incorrectly identified as such, but this bar bears the labial palpi. The gula is a valuable landmark in the case of trichopterous larvæ in showing specialization. It shows that interpretation of the structures of the head in the larvæ of this order as usually adopted are questionable, that the reverse of the usual interpretation must be adopted, for the campodeiform larvæ are the specialized larvæ and not the generalized as the name would suggest.

The limits of the segments, their cephalic and caudal boundaries, are indicated by the membrane between them, the coriæ, that cephalad of the prothorax, the procoria, that cephalad of the mesothorax, the mesocoria, that cephalad of the metathorax, the metacoria, and that cephalad of the first abdominal segment, the unacoria. These coriæ if reduced to sutures are known as the prosuture, mesosuture, metasuture, or unasuture. On each lateral aspect the metacoria is frequently a suture and is known as the interpleural suture. The mesocoria and metacoria usually contain a pair of spiracles, at least in the adult. Each spiracle is surrounded by chitinized plates, a peritreme. The peritremes and imaginary modifications of the cephalic portion of the sternannum of these segments have been designated as the intersegmental sclerites and homologized

with the cervical sclerites with which they are not homologous in position, form, structure, or function. The peritremes are useful in marking the position of their respective coriæ and the coriæ are invaluable in marking the extent of the segments.

The following landmarks are not only available but useful in identifying structures in the thorax and abdomen. The furcinæ, the depressions marking where the furcæ, parts of the entosternum, are invaginated, are important landmarks, since they are always located between the sternannum and sternellum. The other subdivisions of the sternum reported by authors are of very infrequent occurrence and are never demarcated by landmarks other than indefinite furrows of secondary origin. The furcellina and the arm invaginated from it, the furcella, is always attached to the sternellum and when present, even if the sternellum is membranous, marks its situation. The position of the sternellum is also indicated in some insects by its articulation with a coxa, the sternacoila and the sternartis. The trochantins, although usually greatly reduced in size, are generally present, articulated to a coxa by a trocoila, and associated with the sternannum and coxacoila. The flexible membrane surrounding the proximal end of the leg, the coxa, is known as the coxacoria and is of great value in determining the extent of the coxal segment and the sclerites associated with the coxacoria.

The two structures most useful in determining the dorsal and ventral extent of the mesopleura and metapleura are the coxacoilæ and pleuraliferæ. These structures are located, one, the coxacoila, at the ventral end of the pleural suture, the suture which separates the two primary sclerites of each pleuron, an episternum and an epimeron. The coxacoila is where the primary articulation of each leg, a coxartis, is made with the thorax. The pleuralifera is the primary place of articulation of the wing-sclerites, the pteraliæ, with the pleuron. The pleurademinæ, one of which is always located in the ventral portion of the pleural suture and marks the place of invagination of the pleurademe, a part of the entopleuron. The pleurodema always supports the coxacoila and its position in the pleural suture makes it a landmark for both these structures. In the prothorax the large size of the pronotum and the absence of wings and the small size of the pleural

sclerites makes the procoxacoila of great value in identifying the position of the proepisternum and the proepimeron.

The notum always consists of four sclerites, praescutum, scutem, scutellum, and postscutellum, as was shown by Audouin nearly a century ago. A careful study of the structure of the mesonotum and metanotum will show that these sclerites are always present in adult insects and that there is absolutely no foundation for the conclusion of Snodgrass that this area consists of two sclerites, a notum and postnotum, and that in the Orthoptera the postscutellum is not homologous with the same structure of other orders. The limits of the notal sclerites are marked by many easily identified landmarks and four of these are present and can be identified in wingless insects. To identify the limits of these sclerites, generalized insects should be studied and not those with a greatly modified notal area, modifications due to the specialization of the organs of flight, the wings.

The praescutum is the cephalic sclerite and its caudal limit is a transversely invaginated lamella, the prephragma, which becomes so large in specialized insects that the entire praescutum is invaginated into the phragma and the praescutum can not be identified as in all Hymenoptera. There is a second phragma, the paraphragma, usually present and so far as I have been able to discover not previously described. The paraphragma is a transversely invaginated lamella that is horizontal in position and held near the ental surface of the scutum. This phragma is invaginated between the scutum and the scutellum and marks the caudal limit of the scutum. The caudal extent of the scutellum is marked by the spiralis, the spring-like or trachea-like vein always attached along the caudal margin of the scutellum and extending onto the wing of each side to the axillary incision. The postphragma is rarely present and never of large size and is invaginated along the caudal margin of the postscutellum. The very large phragma of such specialized insects as the Lepidoptera, Diptera, and other orders is not a postphragma, but the prephragma of the metathorax. Generalized insects show a distinct prephragma in both mesothorax and metathorax and never a postphragma in the mesothorax so that the so-called postphragma in specialized insects represents an invagination of the metacoria, metapraescutum, and a part of the metascutum with the metaprephragma.

Other definite criteria for the identification of the four notal sclerites is found in the universal position of the alariæ, the places on each lateral margin of the notum where the wing-sclerites, the pteraliæ, articulate. These alariæ can be identified as follows: The cephalariæ on the praescutum, the medalariæ and caudalariæ, always characteristic in form, on the scutum, and the scutalariæ on the scutellum. The value of these points of articulation as landmarks are further enhanced by the characteristic coria located between them, the cephacoria, the medacoria, and the caudacoria. While not a part of this discussion, it may be of interest to note that the scutellum and postscutellum are not only distinct in generalized insects, but three distinct areas or regions can be identified in the former and four to six in the latter.

One of the most important factors to be decided with regard to the abdomen is always the identity and extent of the different segments. The abdominal segments, like the thoracic segments, are separated by coria, the segmacoria. In some of the caudal segments the coriæ are reduced to sutures. Each segment is divided into two parts, a tergum and a sternum united by a coria, the pleuracoria, on each side. The coriæ are the best landmarks in most cases. The most useful single character in identifying abdominal segments is the knowledge that each of the first eight segments bears a pair of spiracles, so that, when there are eight pairs present, one knows instinctively the homology of the last segment bearing a pair of spiracles is the eighth. Nelson has shown the presence of eleven neuromeres and eleven segments in the embryo, but his observations on the closure of the embryo and the formation of the tergum would suggest the absence of a telson so that it would not be possible to consider the abdomen as consisting of either eleven segments and a telson or twelve segments and a telson, but eleven segments without a telson. The cerci are the appendages of the eleventh segment and, when present, will serve to identify this segment. The two remaining segments must be identified from the articulation of the ovipositor or from the position of the parts of the clasping organs, which is not readily done.

ENTOMOLOGICAL SOCIETY OF AMERICA

Proceedings of the Boston Meeting, 1923

OPENING SESSION.

TUESDAY, DECEMBER 26th.

The Society was called to order at 1:50 P. M. by Doctor J. M. Aldrich. In the absence of the President and both Vice-Preisdents, Dr. Nathan Banks was elected Chairman *pro tem.* Professor R. A. Cooley arrived a little later and presided during the remainder of the session. The attendance ranged from seventy-five to eighty. The following papers were read:

Notes on the Life History of *Clastoptera obtusa* and *Lepyronia quadrangularis*. PHILIP GARMAN, Connecticut Agricultural Experiment Station.

A New Type of Insect Metamorphosis Found in Termites. ALFRED EMERSON, University of Pittsburgh.

The Canadian Life Zone. J. M. ALDRICH, United States National Museum.

The Distribution and Forms of *Lygaeus kalmii* Stal, with remarks on Insect Zoogeography. H. M. PARSHLEY, Smith College.

The Malpighian Vessels of the Chrysomelidæ. WILLIAM COLCORD WOODS, Wesleyan University.

The Occurrence of *Muscina pascuorum* in America. CHARLES W. JOHNSON, Boston Society of Natural History.

The Male Genitalia and the Classification of the Genus *Sphaerophoria* (Diptera). C. L. METCALF, University of Illinois.

The following Committees were appointed:

To serve as substitutes for absent members on the Executive Committee: E. D. BALL, C. W. JOHNSON, C. H. KENNEDY, W. P. FLINT.

Resolutions Committee: G. C. CRAMPTON, ALVA PETERSON, GRACE H. GRISWOLD.

Auditing Committee: H. M. PARSHLEY, D. M. DELONG, P. R. LOWRY.

Nominating Committee: C. T. BRUES, J. S. HINE, EDITH M. PATCH.

Adjournment.

SECOND SESSION.

WEDNESDAY, DECEMBER 27th.

The Society was called to order at 10:00 A. M. by the President, Arthur Gibson. The report of the Executive Committee was made as follows:

REPORT OF THE EXECUTIVE COMMITTEE.

The following business has been transacted by the Executive Committee since the Toronto Meeting and is here reported for record.

An invitation was received to hold a summer meeting of the Society at Salt Lake City in connection with the summer meeting of the American Association for the Advancement of Science in June last. The opinions of the members of the Executive Committee regarding the advisability of such meeting were varied and there did not appear to be sufficient interest among the members in such a meeting to justify attempting it.

The resignation last year of Dr. J. M. Aldrich as Councilor in the American Association for the Advancement of Science left a vacancy which had not been filled until the present year. Article 4, Section 8 of our Constitution provides that in case of the death or resignation of either or both Councilors, the vacancy shall be filled by the Executive Committee. The mail ballot of the Executive Committee during the past summer resulted in the designation of the Secretary to represent the Society at this meeting in place of the past President.

On July 27th, the Executive Committee extended an invitation to Dr. W. M. Wheeler, Dean of Bussey Institution, to give the annual public address of the Society at the Boston meeting. This invitation was accepted.

The Executive Committee has extended much more important help to the Secretary in the arrangements for the Symposium for the present meeting. Many invitations were extended that were not accepted for various reasons, but the response on the whole has been very encouraging.

On March 1st, the Executive Committee, by mail ballot, elected the following to membership:

GEORGE C. WHEELER
MAURICE CROWTHER HALL
WILLIAM VICTOR REID
HENRY DIETRICH
CHO TERANISHI
ANDREW FLEMING
CHARLES HOWARD BATCHELDER
J. B. LACKEY

On April 10th the Executive Committee, by mail ballot, elected the following to membership:

JOSEPH BANGHART
NAOTO ISHIMORI
DR. FRANCIS METCALF ROOT

On July 1st the following members were elected by mail ballot:

CLARENCE H. BRANNON
SIMON MARCOVITCH
ALFRED LUTKEN

The Executive Committee met December 26, 1922, at 6:30 P. M., in the Brunswick Hotel, with the following members present: R. A. Cooley, *Chairman;* Herbert Osborn, J. M. Aldrich, O. A. Johannsen, C. W. Johnson, E. D. Ball, W. P. Flint, C. L. Metcalf.

The following were elected to membership:

ALFRED REGINALD ALLEN, JR.
GEORGE F. ARNOLD
HOWARD BAKER
HASTINGS NEWCOMB BARTLEY
JAMES ALLEN BEAL
ARTHUR I. BOURNE
FRED WILLIAM BOYD
MISS HAZEL ELIZABETH BRANCH
JACOB W. BULGER
ELI KIMMIE BYNUM
WALTER CARTER
JOSEPH CONRAD CHAMBERLIN
EDGAR W. DAVIS
CLIFFORD TEN EYCK DODDS
KATHLEEN CLARE DOERING
SENEKERIM M. DOHANIAN
CHARLES FELIX DOUCETTE
PHILIP BERRY DOWDEN
CARL J. DRAKE
GEORGE EDWARD EMERY
DR. TEISO ESAKI
GEORGE A. FILINGER
FRANK CHITTENDEN FLETCHER
ROGER BOYNTON FRIEND
WILLIAM GILBERT GARLICK
DR. JOHN GEO. GEHRING
BERTRAM IRVING GERRY
ALEXANDER A. GRANOVOKY
ARTHUR LEE HAMNER
ROBERT JOHN HARINGTON
EDWIN A. HARTLEY
FRANK MONTGOMERY HULL
PAUL KNIGHT
DR. ELMER F. LEARNED
CHARLES P. LOUNSBURY
WM. MIDDLETON
WALTER MARKLEY MORRIS
BASIL ELWOOD MONTGOMERY
WILLIS BERNARD NOBLE
JOHN CLEARY PEARSON
DONALD T. RIES
HERVEY E. ROBERTS
MAURO G. RODRIGUEZ
HOWARD JEMNEY SAMPSON
CARLTON HILL SCHAFFER
WENDELL FOLSOM SELLERS
HAROLD HENRY SHEPARD
LOREN BARTLETT SMITH
THOMAS ELLIOTT SNYDER
ANTHONY SPULER
GEO. MILTON STERRITT
HOMER S. SWINGLE
LELAND HART TAYLOR
CLARENCE PERCY THORNTON
HARRISON MORTON TIETZ
ARLO MCCRILLIS VANCE
CLAUDE WAKELAND
HERBERT H. WALKDEN
F. E. WHITEHEAD
HARLAN NOYES WORTHLEY

Total New Members elected during 1922, 74.

E. D. Ball moved that the newly elected President appoint a Committee of three of the Executive Committee, to canvass the membership of the Society with a view of election to fellowship. Motion carried.

J. M. Aldrich moved that the Managing Editor of the Annals be requested to publish a complete revised list of the fellows and members in the March number of the Annals. Motion carried.

On motion the Executive Committee recommended to the Society that the annual dues be raised from $2.00 to $3.00, effective January 1, 1924. It was further recommended that the subscription price of the Annals to non-members be $4.00 a year, and that the Managing Editor be authorized to pay a 10% commission to subscription agencies.

Nathan Banks and A. D. MacGillivray were appointed to succeed themselves as members of the Thomas Say Foundation, their terms to expire December 30, 1924. The resignation of E. D. Ball as Treasurer of the Thomas Say Foundation was accepted and J. J. Davis was appointed as Treasurer.

Acting upon the recommendations of the Society at the Toronto meeting, the $50.00 loaned to the Thomas Say Foundation at the time of its organization was made a grant.

R. A. Cooley, R. W. Harned and G. C. Crampton were elected to succeed S. A. Forbes, A. D. Hopkins and A. L. Lovett on the Editorial Board.

The Executive Committee recommended that the Society approve the constitution for the Union of American Biological Societies as published in Science for September 29, 1922; that the Society meet the expenses of our representatives in attending such meetings as may be called in Washington during the coming year; and nominated as representatives in the Council of this Union for the year 1923, A. N. Caudell and A. G. Boving.

The following resignations as members were presented and by action of the Executive Committee these memberships are hereby terminated:

E. D. Quirsfeld
John E. Dudley
Wesley O. Hollister
Everett E. Wehr
J. W. Green
James K. Thibault
Max R. Zappe
R. L. Lobdell

Total, 8.

Last year the Secretary asked the privilege of retaining on the rolls the names of eleven persons who were in arrears for more than two years, and by strict ruling should have been dropped from membership. A personal letter was addressed to each to determine, if possible, whether he really wished to sever his connection with the Society. Of these eleven persons, two have paid up for the intervening years the sum of $22.00. The remaining nine, together with nine others who have passed beyond good standing in the meantime, were by action of the Executive Committee dropped from membership. Total, 18.

One death has come to the notice of the Secretary during the current year, that of Joseph Daniel Mitchell.

Total loss of membership, 27.

Membership reported 1921 (See Annals, XV, p. 104)	606
Loss during 1922	27
Balance	579
New Members elected during 1922	74
Total present membership	653

The present membership is very encouraging. All of the uncertain memberships which had been held for several years following the war have now been cleared up and the total reported above is a genuine active membership. It is the largest in the history of the Society, the largest previously reported being in 1916, with 611 members, the second largest in 1917 and 1921, with 606. It is interesting to notice the growth since 1911, when our membership was 391.

On December 11th, when the Secretary ceased recording payments of annual dues, the Society was in the following condition with respect to payment of dues. In this connection, it may be noted that the above date is somewhat earlier than that used for the corresponding report last year. A number of payments have been made in the interim, but are not as yet recorded.

	This year	Last year
Members and Fellows paid 3 years in advance	9	1
Members and Fellows paid 2 years in advance	2	3
Members and Fellows paid 1 year in advance	179	222
Members and Fellows paid for year just ending	324	235
Members and Fellows 1 year in arrears	23	52
Members and Fellows 2 years in arrears	22	18
Members and Fellows 3 years in arrears	0	11
Life Members	15	13
Honorary Fellows	4	4
New Members	74	47
Totals	653	606

Respectfully submitted,

C. L. METCALF, *Secretary-Treasurer.*

The Report of the Executive Committee was received.

The report of the Treasurer was presented as follows:

REPORT OF THE TREASURER.

(December 21, 1922)

CURRENT FUNDS.

Receipts.

Balance, Dec. 24, 1921 (See ANNALS, Vol. XV, p. 107)	$1,167.12
From Annual Dues of Members	1,069.10
From Managing Editor of the Annals	499.47
From Life Memberships (Moffatt & Mann)	100.00
From Interest	31.10
From sale of bond (Victory Loan called)	50.00
Checks refused by banks (to balance)	12.00
Total Receipts	$2,928.79

Expenditures.

ANNALS for March, 1921, including reprints	$248.00
ANNALS for June, 1921, including reprints	366.50
ANNALS for Sept., 1921, including reprints	311.25
ANNALS for Dec., 1921, including reprints	425.95
ANNALS for March, 1922, including reprints	355.00
Postage, envelopes, stationery for ANNALS	36.30
Engraving for ANNALS (part paid by Treasurer)	56.21
Stamps and Stamped paper, Secretary's office	31.91
Clerical and Stenographic Assistance, Secretary's office	86.66
Printing and stationery, Secretary's office	56.30
Office supplies, Secretary's office	19.00
Express	.78
Telegrams	1.82
Safety Deposit Box	1.80
Lost by exchange	.68
Checks refused by bank (to balance)	12.00

To EDITOR ANNALS for volume for F. Silvestri	4.00
Credit Secretary on account of error in balance for last year as found by Auditing Committee	1.50
Total Expenditures	$2,015.70
Balance, Cash on hand, First National Bank, Champaign, Ill., Dec. 21, 1922	913.09
	$2,928.79

Of this amount $200 belongs to our Permanent Fund ($50 from Life Membership last year, $100 from Life Memberships this year and $50 sale of a bond) leaving an amount available to meet our obligations...$713.09

LIABILITIES.

The Society owes the publishers of the ANNALS for the June, September and December, 1922, issues, being in this respect one issue ahead of our status last year and two issues ahead of our status the year before.

The only other outstanding bill the Secretary knows of is that for the ANNUAL programs which is approximately $25.00.

CONDITION OF PERMANENT FUNDS.

On hand, latest report (ANNALS, Vol. XV, p. 108)	$841.31
Appreciation on nine War Savings Stamps	2.69
Two life memberships, Mrs. Moffatt and Wm. Mann	100.00
Total	$944.00

SECURITIES HELD.

Liberty Bonds estimated at their face value.

First Liberty Loan Bond Bo. B00911757	$ 50	
Second Liberty Loan Bond No. B02787752	50	
Third Liberty Loan Bond No. 5876279	50	
Third Liberty Loan Bond No. 5876278	50	
Third Liberty Loan Bond No. 5876280	50	
Third Liberty Loan Bond No. 4203250	100	
Third Liberty Loan Bond No. 4203251	100	
Fourth Liberty Loan Bond No. H05321828	100	
Fourth Liberty Loan Bond No. C04921513	50	
Fourth Liberty Loan Bond No. D04921514	50	
Fourth Liberty Loan Bond No. E04921515	50	
(The last named converted from No. 14, 145, 891).		
Nine War Savings Stamps	45	
Total Face Value of Securities		$745.00
Balance carried in current account		199.00

Victory Liberty Loan Bond No. A1,562,358 has been called and cashed for face value, $50.00.

Respectfully submitted,

C. L. METCALF, *Treasurer.*

On motion, the report of the Treasurer was accepted and the financial matters involved referred to the Auditing Committee.

The next item of business was the Report of the Managing Editor of the ANNALS.

REPORT OF MANAGING EDITOR.

I am pleased to report that the numbers of the ANNALS issued for the year will be covered by income, and while not as large as might be desired, we believe it will be a creditable volume. The receipts of the office have totalled $745.58; the classified summary of receipts and expenditures being as follows:

Receipts.

Subscription account	$349.51	
Sale of back volumes	85.22	
Reprints and contributions for engraving	310.85	
Total		$745.58

Expenditures.

Stenographic, clerical help and labor	$ 37.26	
Postage, postal deposit, exchange, etc	61.76	
Engraving	147.09	
Balance to Treasurer	499.47	
Total		$745.58

Our library subscription list has been maintained, and foreign subscriptions somewhat increased. The income from back volumes, while not equal to that of last year, will be somewhat augmented by sets recently ordered but not yet paid for. We may, therefore, plan, I think, for a somewhat enlarged volume for the coming year. As in recent years we have had desirable papers that could not be published promptly for lack of funds, and any increase of income can be readily used in the publication of creditable papers.

I am much indebted to Dr. C. H. Kennedy for his efficient assistance.

Respectfully submitted,

HERBERT OSBORN.

On motion, this report was accepted and referred to the Auditing Committee.

The next report was that of the Treasurer of the Thomas Say Foundation.

REPORT OF THE TREASURER OF THE THOMAS SAY FOUNDATION

(For the Year 1922.)

Receipts.

Balance on hand January 1, 1922	$285.73
Seven subscribers at $3.00	21.00
Interest on $200.00 (to Sept. 15)	8.50
Total Receipts, 1922	$315.23

Expenditures.

Postage on seven copies	$ 1.01
Total expenditures, 1922	$ 1.01
Cash on hand to balance	314.32
Total	$315.23
Balance on hand, January 1st, 1923	$314.32

There are outstanding obligations to the original subscribers of $260.00, leaving a net balance of $54.32 to the credit of Volume I if the original grant of the Society of $50.00 is neglected, or $4.32 if it is considered.

E. D. BALL, *Treasurer.*

On motion this report was accepted and referred to the Auditing Committee.

The following report was then presented and accepted:

REPORT OF COMMITTEE ON RESOLUTIONS.

Be It Resolved, that the Entomological Society of America extend its sincere thanks to the Massachusetts Institute of Technology, for its hospitality and for the splendid facilities furnished, which have made these meetings a success.

ALVA PETERSON,
G. C. CRAMPTON,
GRACE H. GRISWOLD.

The Report of the Auditing Committee was not presented to the Society at this session, nor at the later sessions, but by vote of the Society the receipt of this report was delegated to the Executive Committee, with power to act. (Secretary's Note.—Each member of the Executive Committee has approved in writing the report of the Auditing Committee, which is as follows:)

REPORT OF AUDITING COMMITTEE.

Your Auditing Committee has examined the accounts of the Entomological Society of America, the Managing Editor of the Annals, and the Thomas Say Foundation, and finds them to be correct.

(Signed) H. M. PARSHLEY, *Chairman*,
D. M. DELONG,
P. R. LOWRY.

The Report of the Nominating Committee was presented as follows:

For President—T. D. A. COCKERELL.
For First Vice-President—WM. S. MARSHALL.
For Second Vice-President—F. E. LUTZ.
For Members of the Executive Committee—ARTHUR GIBSON, W. A. RILEY, R. A. COOLEY, C. W. JOHNSON, E. P. FELT, A. L. MELANDER.
For Secretary-Treasurer—C. L. METCALF.

On motion, the Secretary was instructed to cast the ballot for the unanimous election of these officers. This being done, the officers were declared duly elected.

The following reports of special committees were read and received:

REPORT OF THE DELEGATE TO THE INTER-SOCIETY CONFERENCE

Washington, D. C., April 21.

At the Toronto meeting, the Society delegated its Secretary and President to represent it at an Inter-society Conference, created to study the feasibility of

a federation of the various biological societies in America, and to develop plans for such a federation.

The Division of Biology of the National Research Council requested that only one representative from each society be sent to this conference. It was agreed that the Secretary should act as the official representative of the Society at this meeting, while the President was good enough to be present on his own responsibility.

This conference, after some debate, affirmed its belief in the desirability and feasibility of a federation of biological societies and adopted a general plan in accordance with which such a federation might be established. Outlines of this plan as it has been further developed and a proposed constitution embodying the details of the plan which was worked out by a special committee meeting in Woods Hole, Massachusetts, August 4 and 5, 1922, have been published from time to time in *Science*, and a rather full report was sent to each member of this Society with the announcement of the present meeting.

(Signed) C. L. METCALF,
ARTHUR GIBSON.

REPORT OF THE SPECIAL COMMITTEE

Appointed to extend to prominent entomologists of Central and South America an invitation to become members of the Entomological Society of America.

At the Toronto meeting the Society appointed a special committee, consisting of the President, the Secretary, and Dr. J. Chester Bradley, to invite officially the entomologists of Central and South America to join the Entomological Society of America.

As a result of the work of this committee, about twenty-five personal letters of invitation have been written to a list of prominent entomologists whose names and addresses were supplied by Dr. Bradley, and most of these have been accompanied by a personal letter from Dr. Bradley.

Up to the present time, no replies have been received from these invitations, but it is hoped that the work may bear fruit that can be reported upon at the next annual meeting.

(Signed) ARTHUR GIBSON,
C. L. METCALF,
J. CHESTER BRADLEY.

On motion the Society voted to enter into the Union of Biological Societies, and to adopt the recommendations of the Executive Committee, as recorded above, with respect to this matter.

On motion the Society voted to raise the annual dues of members from $2.00 to $3.00, and the subscription price to non-members from $3.00 to $4.00, in accordance with the recommendation of the Executive Committee, recorded above. It was moved that the life membership fee be raised from $50.00 to $75.00, but after some debate the motion was defeated.

The following amendments to the Constitution, which were proposed last year, were passed by vote of the Society:

Article V, Section 4, The Election of Honorary Fellows, which read as follows:

All nominations for Honorary Fellows shall be made in the manner prescribed for the nomination of Fellows, (that is, signed by three or more Fellows and accompanied by full information concerning the nominee) the nominations being presented to the Executive Committee, who shall mail ballots to Fellows. Election shall be by mail ballot of the Fellows of the Society, a two-thirds vote of all Fellows being required for election.

is thereby amended to read as follows:

Honorary Fellows may be nominated by unanimous vote of the members of the Executive Committee present at an annual meeting. The nominee shall be voted on by the members by ballot, and must receive four-fifths of all ballots cast to be elected. Not more than one Honorary Fellow may be elected in three successive annual meetings.

Article VI, Meetings, which read as follows:

An annual meeting shall be held in conjunction with the annual meeting of the American Association for the Advancement of Science, and at such time and place as the officers may elect.

is thereby amended to read as follows:

An annual meeting shall be held in affiliation with the American Association for the Advancement of Science, or at such time and place as the Executive Committee may select.

The following amendment to the Constitution was proposed, and will be acted upon at the next annual meeting.

ARTICLE IV, SECTION 3. *Councilors to the American Association.*—The President and the preceding past President shall represent the Society upon the Council of the American Association for the Advancement of Science. In case of the death or resignation of either or both Councilors, the vacancy shall be filled by the Executive Committee.

It is proposed to amend this Section to read as follows:

Two representatives in the Council of the American Association for the Advancement of Science shall be elected by ballot at the annual meeting for the term of one year, and shall be eligible for re-election. In case of the death, resignation, absence, or inability to serve, of either or both Councilors, the vacancy shall be filled by the Executive Committee.

Adjournment.

THIRD SESSION.

WEDNESDAY, DECEMBER 27th.

The Society was called to order at 1:30 P. M. by the President. The following program was presented:

SYMPOSIUM

"ADAPTATIONS OF INSECTS TO SPECIAL ENVIRONMENTS"

PART I.

(Each paper to occupy ten minutes and to present the more noteworthy examples of adaptations to the particular environment discussed, the more striking features of the habitat, and something of the course of evolution or development of the adaptations.)

Adaptations to the Aquatic Habitat. NATHAN BANKS, Museum of Comparative Zoology, Harvard University.

Adaptations to the Subterranean Habitat. HERBERT OSBORN, Ohio State University.

Adaptations to the Boring Habit. J. M. SWAINE, Canadian Department of Agriculture.

Adaptations to Cold. ROYAL N. CHAPMAN, University of Minnesota.

Adaptations to the Fertilization of Flowers. F. E. LUTZ, American Museum of Natural History.

Adaptations of Gall Insects. E. P. FELT, State Entomologist of New York.

Adaptations to Social Life. THOS. E. SNYDER, United States Bureau of Entomology.

Adaptations of Ant and Termite Guests. C. T. BRUES, Bussey Institution.

PART II.

(Each paper to occupy not more than three minutes, and to deal with a single species of insect or a single unit of adaptation.)

The Most Remarkable Adaptation I have Observed Among the:

Orthoptera. JAS. A. G. REHN, Philadelphia Academy of Natural Sciences.
Ephemerida. ANN H. MORGAN, Wellesley College.
Odonata. P. P. CALVERT, University of Pennsylvania.
Trichoptera. CORNELIUS BETTEN, New York State College of Agriculture.
Fulgoridae. Z. P. METCALF, North Carolina State College.
Aphididae. A. C. BAKER, United States Bureau of Entomology.
Coccidae. G. F. FERRIS, Stanford University.
Heteroptera. H. M. PARSHLEY, Smith College.
Micro-lepidoptera. ANNETTE F. BRAUN, University of Cincinnati.
Tipulidae. C. P. ALEXANDER, Massachusetts Agricultural College.
Sarcophagidae. J. M. ALDRICH, United States National Museum.
Tachinidae. J. D. TOTHILL, Canadian Department of Agriculture.
Vespidae. J. C. BRADLEY, Cornell University.
Araneida. J. H. EMERTON, Boston.

It was moved and carried that the Editorial Board be requested if possible to assemble the papers of the Symposium, to be published in a single number of the ANNALS.

By ballot vote, the Society selected as the subject of the Symposium for the Cincinnati Meeting in 1923, "Methods of Protection and Defense Among Insects."

Adjournment.

FOURTH SESSION.

WEDNESDAY, DECEMBER 27th.

The Society was called to order at 8:30 P. M. by the President, who introduced the speaker of the evening, Doctor W. M. Wheeler, who delivered a most entertaining and instructive address on "The Physiognomy of Insects." The attendance at this session was about 250.

Following this address the Society adjourned to attend the biologists' smoker in Walker Memorial Hall.

FIFTH SESSION.

FRIDAY, DECEMBER 29th.

The Society was called to order at 10:00 A. M., with the President in the chair. The following papers were presented:

Technique in Studying by Dissection the Internal Anatomy of Small Insects. RALPH H. SMITH, San Francisco.

The Insect Collections of the Boston Society of Natural History. CHARLES W. JOHNSON, Boston Society of Natural History.

Stone Flies of the Genus *Nemoura*. P. W. CLAASSEN, Cornell University.

The Exoskeleton as a Factor Limiting and Determining the Direction of Insect Evolution. CLARENCE H. KENNEDY, Ohio State University.

Wing-venation of the Buprestidae (Coleoptera). HENRY G. GOOD, Cornell University.

Injury to Wood Caused by Oviposition of *Ceresa bubalus* Fabr. F. A. FENTON and J. C. GOODWIN, Iowa State College.

Notes on Insect Polyembryony. R. W. LEIBY, North Carolina Department of Agriculture.

Some Observations on the European *Dichomeris marginellus* Fabr. L. HASEMAN, University of Missouri.

The following exhibits were available for examination during the entire course of the meetings:

An Inexpensive and Efficient Variable Illuminator for use with the Binocular Microscope. C. T. BRUES, Bussey Institution, Harvard University.

Drawings of the Fulgoridae of Eastern North America. Z. P. METCALF, North Carolina State College.

Larval Habits of *Coleophora coenospiennella*. ANNETTE F. BRAUN, University of Cincinnati.

Photographs of Scent-organs in the Genus *Hydroptila* (Trichoptera). MARTIN E. MOSELY, London, England.

SPECIAL NOTICE TO MEMBERS.

The revised membership list of the Entomological Society of America will be published with the June issue. At the request of certain members the Secretary will undertake to include in addition to the correct address a statement of the taxonomic group in which any member is especially interested and whether he is willing to make identifications in such group. Members are therefore urged to make sure that the Secretary has their correct mailing address and also a statement of their special interests, if such statement has not been made on the information blank already sent to the Secretary.

C. L. METCALF, Secretary-Treasurer,
Nat. Hist. Bldg., University of Illinois, Urbana, Ill.